THE TELEGRAPHIC JOURNAL AND

Electrical Review.

Vol. XII.—No. 275.

THE ELECTRIC LIGHTING ACT.

In our last number we concluded our comments on certain parts of the draft "Provisional Orders" under the Electric Lighting Act, 1882, compiled by Mr. J. Fletcher Moulton, F.R.S. No one can have failed to be impressed by the difficulties yet to be overcome before electricity can be looked upon as becoming the general source of our artificial illumination. We stated at the beginning of the year that Mr. Moulton had been careful to deal fairly both with the public and the undertakers, and the more we consider the question the more do we feel convinced that Mr. Moulton's arduous labour has been accomplished in the most complete way possible at the time he undertook such an important task. We congratulate him heartily on his admirable production.

That the remarks we have from week to week made on the more technical portions of Mr. Moulton's work are likely to be thoroughly discussed is apparent from the correspondence now going on in our columns on these most important points for consideration, viz., electric light conductors and the "unit" to be adopted in order to enable a clear and reasonable determination to be arrived at as to the price to be charged for the supply of electricity. We should have been glad, however, if some of our readers could have seen fit to criticise those portions of the Orders dealing more immediately with the commercial arrangements between undertakers and consumers. Indeed, as it is, we have every reason to be satisfied with the result we have obtained by devoting so much of our space to bringing nearly every section of the "Provisional Order" before our subscribers.

THE PROBLEM OF THE TELEPHONE.

This is the title of an article in the *Scientific American*, a few extracts from which will probably be found of interest. Now that a temporary lull has taken place in the progress of electric lighting, telephony seems to be taking a firmer hold upon the public mind, and the situation of matters telephonic in America is apparently in a much more complicated position than at home. Our contemporary says:—

"That the American Bell Telephone Company is master of the telephone field must be acknowledged. Every telephone user knows it. Every would-be user knows it. Every telephone inventor knows it. The recent consolidation of telephone interests, the massing of capital, the successes in court, have made this company a tower of strength. With a capital of 10,000,000 dols., swelled by premium to 18,000,000 dols., with legal advisers, and experts schooled in the art of telephony from the beginning, and with judicial prejudice in its favour, it appears futile for a rival to attempt a contest with so powerful an opponent. If the claims of the Bell patent are to be construed by every court as covering any and all methods of transmitting speech electrically, then telephone inventors must be content with the bare possibility of disposing of their inventions to the controlling power; but if, on the other hand, the Bell patents are found to cover only a specific method and apparatus for transmitting speech, then there is a field in which inventors may work with prospects of a reward.

"Hitherto, nothing has transpired in court by which the true status of the Bell patent has been defined, for in no instance has the court passed upon the merits of the questions at issue. The decrees have been obtained by default, or by consent, or in consequence of admissions of the defendants, which rendered it unnecessary for the court to decide upon the merits of the case.

"It is held by some that the Bell patent covers only the method of and apparatus for transmitting speech electrically by means of undulatory currents of electricity. It is held by the Bell counsel and experts that there can be no other method, while it is claimed by others that another method and other apparatus may be employed to accomplish the same end. In all these phases of the telephone problem there arise questions for which there is now no answer. The most intricate points of law as well as the most subtile physical principles are involved; and now the question is as to the advisability of pursuing telephone investigations for purely monetary considerations. Any one familiar with the present status of telephonic apparatus can readily see that there is no greater field for study, and none that has greater promise of profit in it, than that of telephone invention.

"Let the legal aspect of the matter be as it may, it is positive that the accomplishment of certain improvements in the telephone would yield a far richer harvest than has been reaped by any inventor in this line. It should be no source of discouragement to the determined and intelligent inventor that hundreds, and probably thousands, have reached toward the prize with a grasp too short, for it is only a faithful index of the great value of the prize that so many have striven for it."

The London and Globe Telephone Construction and Maintenance Company v. The United Telephone Company.—In the Chancery Division of the High Court of Justice, on Thursday week, before Mr. Justice Fry, Mr. Cozens-Hardy, Q.C., and Mr. Moulton moved, on behalf of the defendants, to discharge an order which had been made in this action, restraining their issuing advertisements in a form which implied that Hunning's and other carbon transmitters could not be manufactured or sold without their licence. The motion was made on the ground that the circumstances on account of which the injunction was granted no longer applied. It may be remembered that in the motion against Harrison, Cox-Walker & Co., in which the present defendants sued to restrain the infringement of Bell's patent for receivers and Edison's patent for transmitters, his Lordship held that Edison's patent was void by reason of excessive claim, inasmuch as the patent claimed the phonograph—an instrument not sufficiently indicated in the provisional specifications. His Lordship therefore refused to restrain the manufacture and sale of Hunning's carbon transmitter, which, his Lordship held, would have been an infringement of Edison's patent if the excessive claim had not been made. The injunction in this action was founded on that decision. The defendants, however, have since, under a fiat obtained from the Attorney-General, disclaimed the phonograph and established their patent, and on that ground made the present motion. Mr. Northmore Lawrence (Mr. Hemming, Q.C., with him), for the plaintiffs, opposed the motion, on the ground that the Attorney-General's fiat, as was usual, was granted on the condition that instruments already made should be protected, and that the plaintiffs had many thousands of such instruments for which they claimed protection. Mr. Justice Fry held that, the ground for the injunction having fallen, the injunction should be dissolved; but inasmuch as the right to disclaim had, so to speak, been purchased by the defendants on terms of the existing instruments being privileged, they ought to undertake not to issue such advertisements without calling attention to the reservation in the Attorney-General's fiat, and as the granting of the injunction was proper at the time it was granted, the defendants must pay the costs of this application to discharge it.

ON ELECTRIC LIGHTING FOR WORKSHOPS AND LARGE SPACES.

By Mr. ANDREW JAMIESON, A.M. Inst. C.E., F.R.S.E., &c., Principal, College of Science and Arts, Glasgow.

(*Continued from page* 158.)

The Crompton-Bürgin dynamo is a very practical and useful modification of the Gramme dynamo. It is constructed either for arc lighting or for incandescent lighting purposes. When constructed for the latter work, the electro-magnets are specially wound on the combined series and shunt principle, with a view of rendering the generation of the current automatically proportional to the number of lamps in circuit, and keeping the electromotive force constant for a constant speed.

By referring to figs. 7, 8, 9, and 10, where fig. 7 is a perspective outside view, fig. 8 is half a section through armature parallel to shaft and half outside view, 9 a half section through electro-magnets and a half end view, while 10 is a perspective view of the armature alone.

INDEX OF PARTS.

N, P	represents the negative and positive terminals of machine;
M, M,	the electro-magnets, which are two solid iron castings, planed, bolted together, and bored and faced to admit
R,	armature ring, and receive the gun-metal end covers which form bearings for
S,	spindle carrying the driving pulley, A.
B, B,	two brushes for making contact with
C,	commutator (fig. 6). These brushes are fixed in
D,	holder, and brought to bear upon C, by
E and G,	set screw and spring arrangement.
H,	eye-bolt for lifting machine with.

The armature ring, fig. 10, is one of the special features of this machine. It is the single Gramme ring split up into a large number of individual rings, R. The coils of wire, W, of these rings which are wound round hexagonal iron cores composed of soft iron wire, I, are connected in series to the sections of the commutator, C, where the current is collected in the usual way by two brushes, B. This machine has several advantages :—1. It lies low, is well constructed, and free from vibration. 2. Armature coils easily made and repaired. 3. The armature admits of being accurately balanced and rapidly rotated. 4. The small number of *layers* of wire on armature rings, with a free circulation of air *between* the spokes, prevents undue heating.

We may here state that all dynamos on important circuits should be fitted with accurately indicating tachymeters, or continuous speed indicators. This is a point which is too often neglected, although it greatly assists those in charge in keeping up a steady motion.

CONDUCTING WIRES OR LEADS.

These should, in all cases, be carefully proportioned to the strength of the current they may have to carry, and to the distance through which it has to be conveyed ; for, when electricity flows through resistance, energy is spent in heating the matter through which it flows. For practical use, the heat generated by a current of electricity in time, $T, = C^2 R T \times 0{\cdot}2405$ (gramme degrees), where C = ampères, R = ohms, and T = seconds. Hence it is that if the conducting wire be too small for the current it has to convey, it will become warm, which still further increases its resistance—ultimately producing incandescence, and even fusion, endangering property by fire. Again, although the wire may have sufficient conducting power for the current, without undue heating at any part, yet its length, and consequently its resistance, may be so great that the total amount of heat generated, or energy misspent on it, will considerably reduce the efficiency of the system. (The rules laid down in the new Electric Lighting Draft Provisional Order were read and commented upon).

ARC LAMPS.

In dealing with electric lighting for workshops and large spaces, I need only consider arc lamps, as neither the incandescent nor semi-incandescent lamp is so suitable as yet. I shall describe a few of them, in the alphabetical order of their names.

Akester's Lamp is one of the simplest forms of arc lamps that I have met with. It is only arranged to be worked as a single lamp, but there would be little difficulty in so winding a shunt coil, and fitting the extra necessary parts to it, as to make it serviceable to be worked in series with a large number of others of the same kind. Most of the modifications of arc lamps, of which there are so many patents, aim at keeping the + and — carbons at a uniform distance when in action, to produce a steady light. This is generally done by combined electrical and mechanical action.

Referring to fig. 11, and

INDEX OF PARTS.

S, S	represents solenoid coil of copper wire, No. 10 B.W.G., insulated by cotton and shellac varnish.
I, C,	iron core (hollow).
F, S,	quickly pitched six-threaded screw (1¾ in. pitch).
N,	nut with lower upturned milled edge.
P,	pawl or lever held down by a bent spring.
C, H,	carbon holders.
C +, C,—	carbons 13 millimetres diameter.
G R, G R,	parallel iron guide rods.
B C H,	brass crosshead.

In this lamp the current, in passing from the dynamo to the upper carbon, traverses the solenoid coil, S, S, acting inductively on the hollow iron core, I, C, and sucking it upwards, thus lifting the upper from the lower carbon by engaging the nut, N, which is fitted to the central screw, F, S. The milled edge of the nut comes against the lever pawl, P, and is therefore prevented from turning round, thus limiting the length of arc. As the arc burns longer the resistance of the circuit increases, the current thereby necessarily diminishes in strength, and the lifting power of the solenoid becomes less, allowing the iron core to drop a minute distance, just sufficient to clear the milled edge of nut, N, from the pawl, P, the nut turns round through a degree or so, which allows the carbon to drop a very small distance, the normal length of arc being in this way resumed. The above operation takes place so rapidly that the upper carbon is fed forward in almost perfect unison with the consumption, insuring a steady light.

From tests which I made of this lamp, an actual, not nominal, candle-power of 2,250 candles, or 1,450 candles per horse-power at the lamp, was obtained, the electricity being furnished by an A Gramme dynamo.

I would like here to explain and clear up an ambiguity which has arisen and which is very confusing to those not acquainted with electrical phraseology. When the expression, so many candles per "electrical horse-power," or so many candles per horse-power expended in the lamp, is used, it is to be understood that the electrical energy absorbed by the lamp, and developed in the form of heat and light, is, according to the formula $\frac{E \times C}{746}$, which we stated at the beginning of this lecture was an actual horse-power of 33,000 foot pounds per minute. This takes no account whatever of the energy lost in transmission through the leading wires, or that absorbed by the dynamo, or that spent on the moving parts of the engine shafting and belting through friction, &c. It is considered fairly good work, in actual practice, if we get 60 per cent. of the horse-power, as indicated by diagrams taken from the steam cylinder, in the form of electricity, at the lamp carbons or arc. The loss of power in conversion and transmission may be roughly computed as follows :—

Loss by friction, &c., in engine, &c.,	10	per cent.
„ in conversion of mechanical to electrical energy in dynamo, by heating, friction, &c.	20	„
„ by heating leading wires and lamp circuit coils	10	„
Total loss	40	„

One has therefore always to be on his guard when inquiring "how much power such and such a lamp or system gives in the form of light;" and it is generally necessary to ask the question, "Do you mean so much cylinder horse-power, or so much dynamical horse-power, or so much in the form of electrical energy at the lamp?"

Brush Lamp (see fig. 12).—Perhaps no lamp has been so extensively adopted as the Brush lamp in workshops and streets. Its popularity and success mainly depend upon the fact that it is arranged so that a large number can be included in series and worked from one dynamo. As many as 40 of these lamps have been worked, in numerous instances, by one machine, while the whole system is so adjusted by means of an automatic carbon regulator that one or more of the lamps can be extinguished or removed without endangering the others remaining in circuit. The only danger arising from using such a large number of lamps in circuit, placed in series, is the necessarily high electromotive force of the current, attended as it is by rapid fluctuations in strength. The normal electromotive force or difference of potential between the terminals of each lamp being 45 volts, 40 such lamps, *irrespective* of the leading wires and dynamo, require an electrical pressure of 1,800 volts, or about 2,000 volts including the dynamo and leads; and therefore the connections and leading wires should be well insulated, and the handling of the same should be done with care and caution. The normal strength of current is 10 ampères, so that each lamp absorbs energy to the amount of E × C = 45 × 10 = 450 watts.

By comparing the theoretical diagram (fig. 13) with fig. 12, and the following description of details, the principle and action of the lamp will be easily understood. Only one coil and carbon are shown, for simplicity, although there are generally two.

INDEX OF PARTS.

T + and T — represent lamp terminals.
F, C, hollow feed coil with thick copper wire (0·12 ohm resistance) wound round it in a right hand spiral, terminating at
S, C, slip contact bearing on carbon holder.
Also round F, C, is wound a thin copper shunt wire (160 ohms) in a left-hand spiral. This fine wire is continued to and wound round
C, O, cut-out coil (40 ohms) to terminal (T —).
I, C, iron core, which is sucked up inside F, C, under the preponderating influence of the stronger current passing through the thick wire against gravity, and against the effect of the weaker current passing through the fine shunt wire, thus lifting
L, lever, which tilts
W, washer or clip ring, which in turn lifts
C + upper carbon from
C — lower carbon, thus forming the arc.

The upper carbon falls towards the lower one periodically, being automatically retarded in its progress by the action of the varying proportions of current passing through the thick and thin wires of the feed coil, F, C, due to the varying length and consequent resistance of the arc.

The cut-out coil is also wound with a thick copper wire in the same direction as the fine wire around it, but the thick wire is only brought into circuit on the carbons burning out, or extinguishing of the lamp and breaking the arc through an accident. Should this take place, a greater proportion of current than usual flows through the fine wire, strongly magnetising the iron core of the cut-out coil, C, O, which attracts the iron keeper, K, fixed to lever, *l*, thus establishing a low resistance circuit for the main current by way of spring, S, lever, *l*, contact, *k*, through thick wire of C, O, to terminal (T —), and thence to the next lamp in the series, effectually cutting the lamp in question out of circuit until put to rights.

I tested the candle-power, the other day, of one of the Brush lamps at the Aberdeen installation, where they have dispersed along Union Street, Market Street, &c., in a circuit of a mile and a half, 16 lamps of 2,000 (nominal) candle-power, and found it to give 567 candles, measured at an angle of 30 degrees from the horizontal. The lamps are placed on 20-feet wooden poles, and the centre of the arc of the one which I measured was 20 feet 10 inches from the ground, which appeared to be a very suitable height for distributing the light. The lamp was fitted with clear glass globes, which, from various tests which I have made with clear glass, will reduce the candle-power about 10 per cent. of that given by the naked light. I also tested one of the 32 Brush lamps daily at work at Messrs. Mirrlees and Watson's engine works, where they use strongly frosted globes with a view to soften and diffuse the rays of light and render it more agreeable to work under. These globes reduce the candle-power about 50 per cent., and the mean which I got was 310 candles. The workshop engine is used, and it appears that 17 lamps are worked by one machine for an expenditure of 19 indicated horse-power, as measured by diagrams taken from the cylinder; or, say roughly, 1·1 indicated horse-power per lamp, or 54·5 per cent. of the horse-power developed in the cylinder is usefully employed in the form of electricity at the lamps.

The Crompton Arc Lamp.—This lamp is very suitable for railway stations and large spaces where a powerful light of 2,000 or more candles is desirable, and where plenty of elevation can be obtained.

Referring to fig. 14, it will be seen that the upper part, which contains the mechanism, consists of a pair of top and bottom plates, united by a pair of flat frame plates, which form the sides carrying the train of wheel work. The upper carbon holder terminates in (B) a solid rod of brass, with a rack cut on one side of it. This rack gears with the largest and lowest wheel of the train. The top wheel (E) of the train is termed the brake wheel, and is fitted with a centrifugal governor to regulate its speed. The brake mechanism, N, consists of a lever pivoted on its centre, so that when the end, N, is attracted towards the pole of the shunt coil magnet, C, it overcomes the tension of spring, R, and releases the brake wheel, E, allowing the upper carbon to fall by gravity towards the lower one. So long as no current is passing, the spiral spring, S, pushes up the tube, A, carrying the lower carbon holder, O', so that the carbon points are in contact; but whenever a current of sufficient strength passes through the electro-magnets, M M, the armature, L, is attracted downwards towards its iron cores, and with it the tube, A, to which it is fixed, thus separating the carbons, and forming the arc to its normal length. While this normal length of arc is maintained, a constant but small proportion of the main current passes through the high resistance shunt coil, C, which is connected between the main terminals of the lamp, just sufficient to maintain the brake mechanism (described above) in equilibrium. A very slight increase in the length, and consequently in the resistance, of the arc, causes more current to pass through the shunt coil, C, which then releases the brake from wheel, E, and allows the upper carbon to descend until the arc again assumes its normal length. The feed mechanism is therefore entirely actuated by the varying resistance of the arc causing a greater or less proportion of the total current to pass through the shunt coil, C.

Messrs. Crompton's firm state that they obtain by this lamp effective lighting for 200 square yards of station floor area, both at Queen Street Station, Glasgow, and King's Cross Station, London, for an expenditure of only one pound of coal per hour, by using Messrs. Marshall and Son's economical engines. You have, no doubt, all witnessed the performance of this lamp at Queen Street Station, Glasgow, and I think every one admits that it is the best-lighted station in the kingdom. Mr. Hobson, the Postmaster, is so well pleased with this lamp at the General Post-office that he has entered into a two years' working contract for the lighting up of the larger spaces in the Post-office, while the smaller offices and rooms are to be lighted, within a few weeks, by means of Swan's lamps.

I think arc lamps, both in railway stations and workshops, should be so placed with regard to distance apart and height, that no part where work or business has to be carried on should have less light than that equal to one standard candle at 2 feet distance. For the Brush lamp, reckoning them as averaging 500 candles with clear globes, this would mean placing them at a height of 22½ feet and 26 yards apart, and would give a good light to read or work by, while not too strong or trying to the eyes. For streets, the Brush lamps might still be placed at a height of 22½ feet and about 60 yards apart, or with a minimum light at the further parts from the lamps of about equal to 1 candle at 4 feet distance.

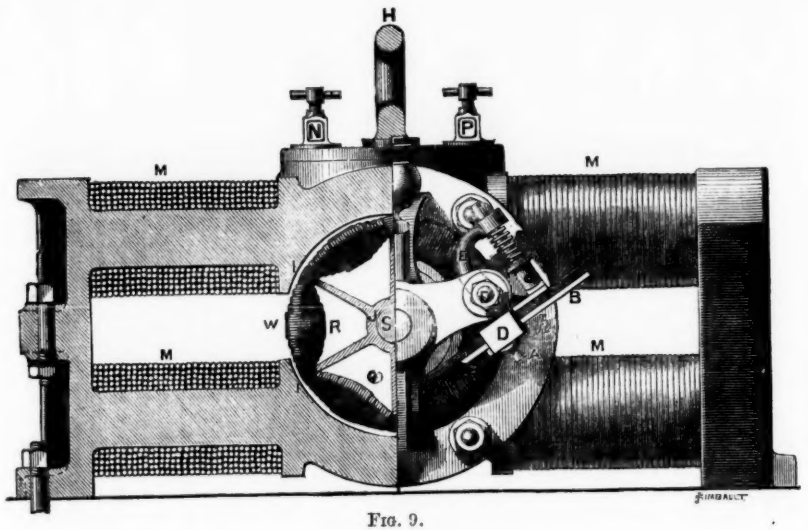

FIG. 9.

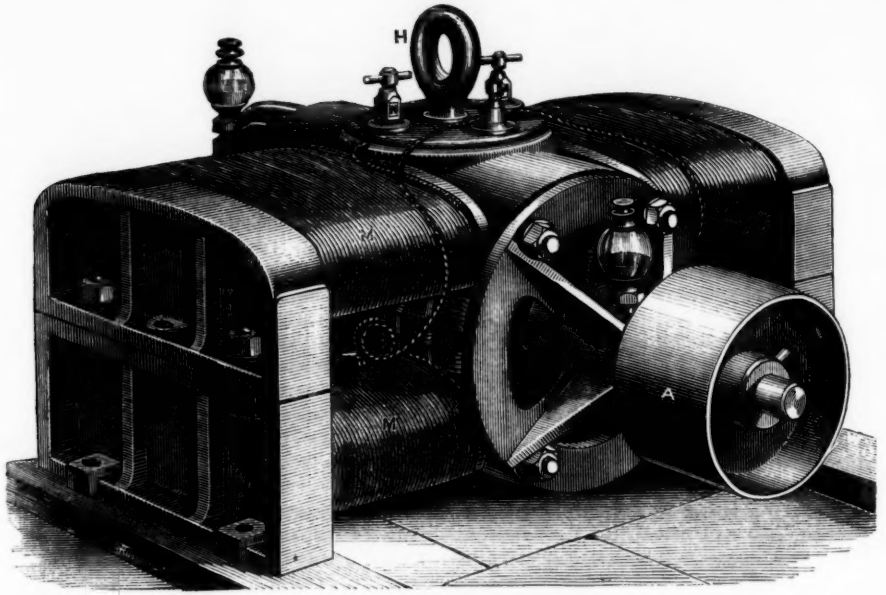

FIG. 7.

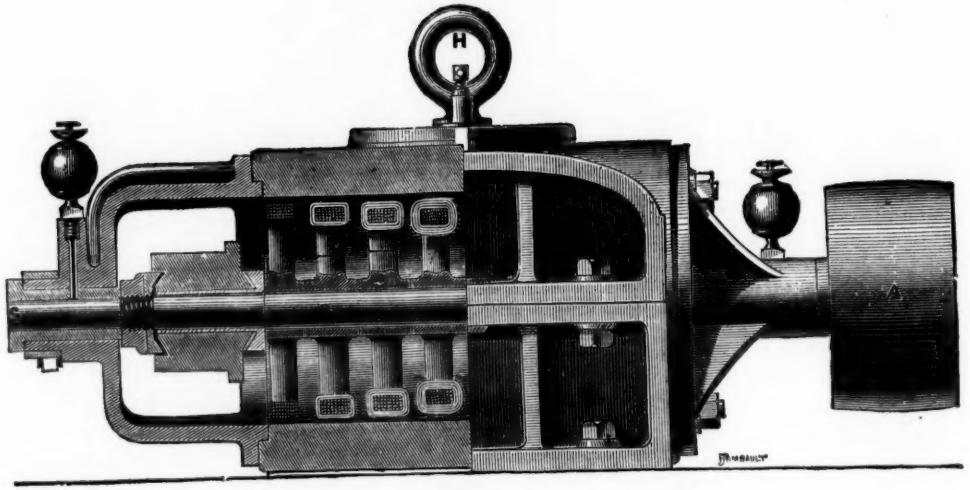

FIG. 8.

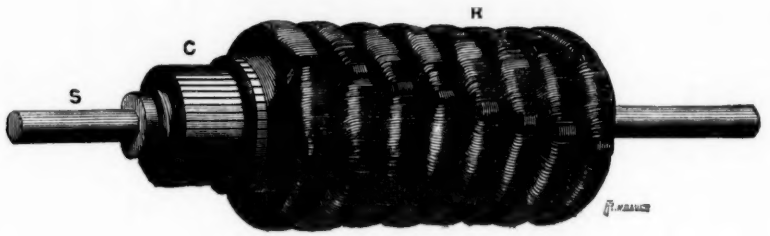

FIG. 10.

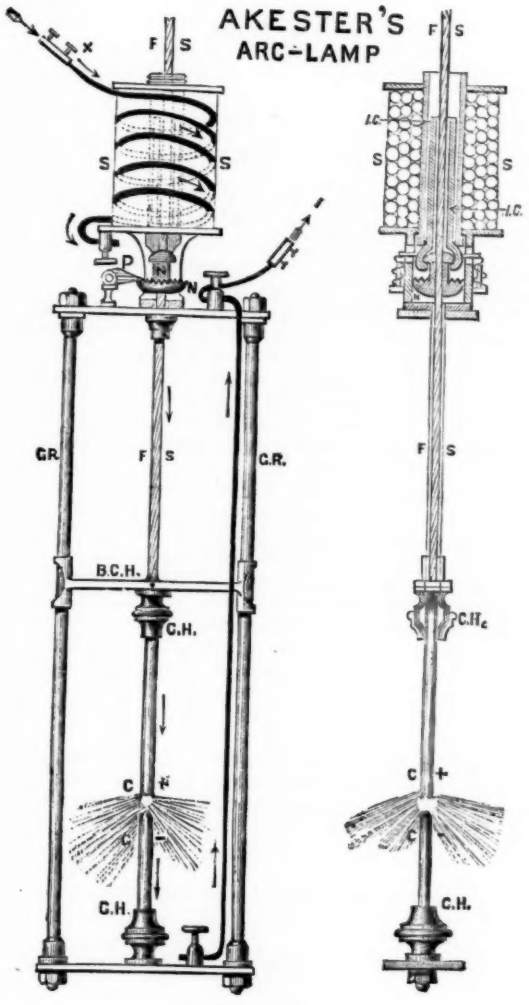

FIG. 11.

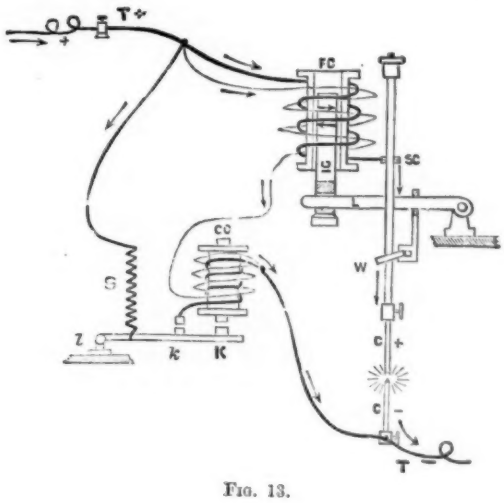

FIG. 13.

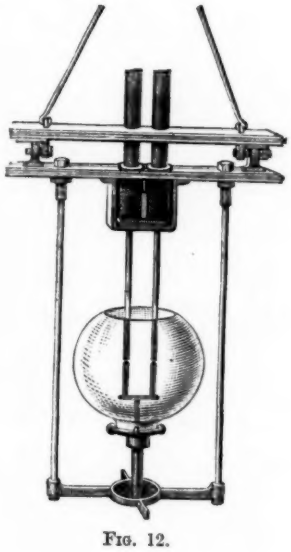

FIG. 12.

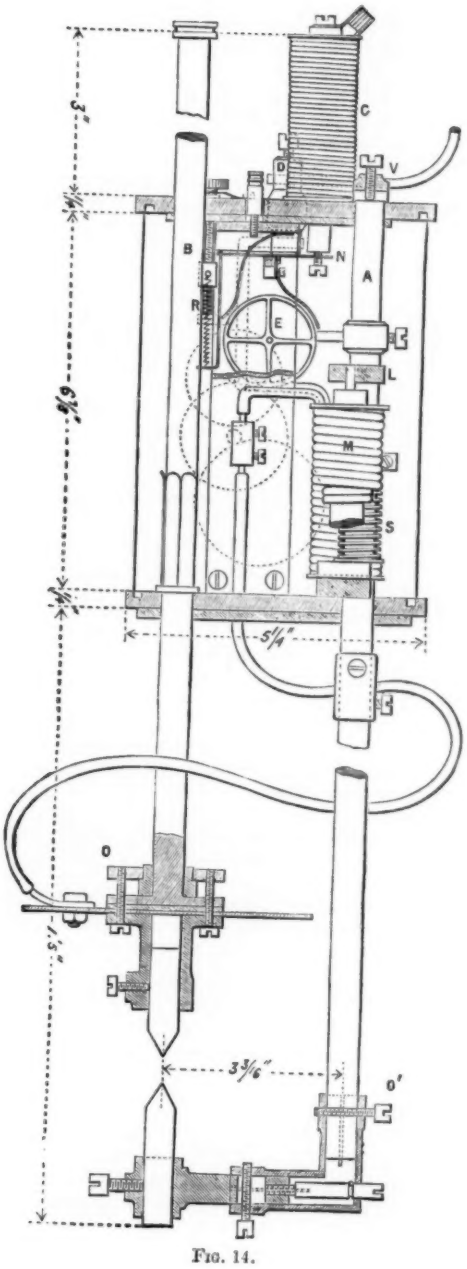

FIG. 14.

In workshops, streets, and large spaces, the lamps should be so placed zig-zag that the light from each tends to dispel or cancel, as far as possible, the shadows cast by the others.

It is worthy of mention that Messrs. A. & W. M'Onie, who have lately adopted the Brockie lamp worked by the A Gramme dynamo (which were shown at the meeting), are able to photograph their working drawings by means of the electric light. They have fitted up a special room for the purpose, and obtain a clearly-defined copy of a drawing 3 feet 6 inches by 2 feet 6 inches in twenty minutes. The light is placed 2½ feet from the drawing, and the latter moved to the right or left until the whole photograph is equally well brought out.

ELECTRICAL INSTRUMENTS FOR MEASURING THE STRENGTH OF CURRENT AND THE ELECTROMOTIVE FORCE.

The development of electric lighting has necessitated the invention of special instruments for measuring stronger currents and greater electrical pressures than were demanded by those used for submarine and other telegraphic and scientific purposes, and we are fortunate in being able to place before you this evening the latest and best that have yet been produced, viz.: Sir William Thomson's graded galvanometers, made by Mr. White, the well-known optician, of Sauchiehall Street. (These instruments, and methods of using them, were described to the meeting.)

RELATIVE COST OF ELECTRIC AND GAS LIGHTING FOR WORKSHOPS.

We now come to compare the relative cost of electric lighting and gas lighting.

There can be no doubt that the introduction of electric lighting has greatly spurred on inventors and gas managers to make more of the gas than formerly, and the consequence is that we have gas burners rivalling the electric light both in brilliancy and economy.

There are being fitted at the present moment, to the Clyde Navigation Graving Dock, a large number of Bray's powerful gas lamps. Also, the Clyde Trust have in operation one of Siemens' 400-candle-power lamps, and are having fitted up 20 of Siemens' patent regenerative 130-candle-power gas burners, in place of the former mode of lighting by 30 cowl-shaped crystal basins, each containing four No. 4 gas jets. Each of these systems of gas lighting has certain advantages which the other does not possess, and for each certain advantages are claimed against that of electric lighting. There can be no doubt but that the Siemens burner is more economical than Bray's, as far as the amount of light given out for a certain consumption of gas, for it is found that while the Bray lights give 5·7 candles per cubic foot of Glasgow gas, the Siemens burner—as we shall prove further on—yields 7·8 candles per cubic foot of the same gas; but then the Bray lights admit of being turned down to one small jet, when the full flame is not required, more readily than the Siemens burner.

From tests made by Dr. Wallace and myself of these Siemens burners, it appears that 408 candles are obtained from a consumption of 52·2 cubic feet per hour, or 7·8 candles per cubic foot; or say 39 candles for 5 cubic feet per hour, or an improvement in the economy of using gas of 46 per cent. over that of the best small burner which is used in testing the Glasgow 26-candle gas (*i.e.*, 26 candles for 5 cubic feet per hour).

Let us compare this with the Brush lamp under similar conditions as to globes and lanterns. We got 567 candles from the Brush lamp at Aberdeen with clear globes.

Cndls. Cndls. Cb. ft.
∴ 408 : 567 :: 52·2 : x = **72·5** cubic feet per hour

of Glasgow gas required by Siemens' burner to produce 567 candles. Now Glasgow gas costs 3s. 8d. per 1000 cubic feet.

Cb. ft. Cb. ft.
∴ 1000 : 72·5 :: 44d. : y = 3·19d. for gas alone per hour.

To this we have to add, say, 20 per cent. on first cost of lamps and fittings (£30), as well as depreciation on same—or £6 per annum. Allowing this to be distributed over 3650 hours, or 10 hours' lighting per day, we have

Hours. Hour.
3650 : 1 :: 1,440d. : z = 0·39d. per hour

for interest and depreciation of plant. We have also to count something for attendance, and this cannot be reckoned at less than one farthing per hour per lamp. Adding these sums, we have

3·19d. per hour for gas.
0·39d. „ „ interest, &c.
0·25d. „ „ attendance.

Total cost, 3·83d. per hour.

And this with by far the most economical method yet devised for burning gas.

I understand that the Brush Company of Scotland are willing to lay down all the necessary plant, including steam boiler, engine, dynamo, leads, lamps, &c., complete, and guarantee their proper working, paying all expenses, including carbons, &c., for a system of 40 arc lamps, to any person or combination of persons within reasonable distance of each other, and charge them only 3d. per hour per lamp during every 3650 hours of lighting per annum. This is a straightforward and practical way of putting it; and should the lights be required for a proportionately less time per annum than the 3650 hours, they will be able to tell you the small fractional extra expense per hour which it will cost.

Since the meeting I have been informed by Messrs. Bray & Co. that the price per hour for each of their 500 candle-power gas lanterns burning in Glasgow, at full power, for 2000 hours per annum, would be 4·375 pence. This estimate includes erection, interest, and maintenance of plant in good working order. If, however, their double-service system be adopted—that is, lowering the lamps at midnight to one jet of 30 candles (or 1000 hours at 500 candles and 1000 at 30)—the price is reduced to 2·875 pence per hour per lamp. The above does not include lamplighters' wages, which we may reckon at one farthing per hour per lamp as before.

The discussion on Mr. Jamieson's lecture was not of a very important character, the users of the electric light speaking, without exception, in very favourable terms on its merits.

ELECTRO-MOTORS.

SOME OBSERVATIONS ON THE DETERMINATION OF THE WORK EFFECTED BY ELECTRO-MAGNETIC MOTORS.

By A. VON WALTENHOFEN.

WHILE Jacobi (1840) has furnished us with the foundations of a theory of electro-magnetic machines, Grove (1844), Joule and Scoresby (1847), and W. Petrie (1851), must be mentioned as the first who have given us exact information concerning the work effected by electro-magnetic motors.* For this purpose the above-mentioned physicists started from the first principle, viz., to compare the theoretical consumption of zinc requisite for the maintenance of one horse-power with that which was actually expended per horse-power by the motors employed in the above-mentioned experimental determinations of the work effected and consumption of zinc. Out of all these results only those of W. Petrie can be looked upon as resting on reliable data, for those of the other physicists before-mentioned give such an enormously high return of work, that its inaccuracy can admit of no doubt when tested by the knowledge that we possess at the present day of the capacity of work of the best electro-magnetic motors. W. Petrie is also the only one who clearly and expressly states in his report that he has duly taken into account that the theoretical work effected in proportion to the unit of weight of zinc depends upon the nature of the circuit in which the consumption of zinc takes place; and also the only one who has strictly applied the principle just laid down for determining the return of work.

This principle—viz., the equivalent of work (to be

* Jacobi has not entered upon this question himself, he says on the subject: "In my numerous experiments on electro-magnetic machines I have not been able to determine, either exactly or approximately, the quantity of zinc which must be expended in order to obtain a unit of work, and have not seriously endeavoured to do so." Hereupon follows an exposition of his reasons for making this statement.—"Kronig's Journal," 3, p. 399, 1851.

looked upon as effective work) of the chemical processes taking place in the generating battery, is simply the one that I have myself maintained in a form which, although quite different, is in accordance with these more recent investigations. On the other hand, my mode of procedure in my experiments was quite different to the earlier methods.

In the first place, in the reports of the physicists in question the returns of work effected were measured directly on the machine, in foot-pounds, by means of the raising of weights, whereas I first employed the break dynamometer for the testing of electro-magnetic motors. In the second place, the consumption of zinc was formerly measured by weighing the plates of zinc before and after the experiments; whereas I, instead of employing this clumsy and roundabout method, took the measurement of the current by means of the tangent galvanometer, in order to reckon from the product of the current and the known electromotive force of the battery, the effective work in kilogrammetres per second, and from the comparison of the effective work so determined with the work measured by means of the break dynamometer to deduce the efficiency of the electro-magnetic machine to be tested.

The theoretical explanation of this method of procedure, which I gave at the time, also follows from the formula communicated by Clausius in a note on the relation between the chemical action of a voltaic pile and the work effected by the current.* Let J represent the battery-current in the motor which is in working order, but which is stationary, and $J - i$ the battery current during the working of the motor, therefore i the counter current induced by the working of the motor, and λ the total resistance of the current circuit, we get the equation :—

$$J\lambda(J - i) = i\lambda(J - i) + (J - i)^2\lambda.$$

In this equation the first term represents the current work given off from the battery when the motor is driven or the total work, D; the second, the mechanical work performed in the machine, consisting of useful work, N, and of friction, R; and the third, the current work, W, entering into the circuit as heat. The degree of efficiency is as N : D. In order to find D we now use my method of measuring the current during work, $J - i$, by means of the tangent galvanometer, while $J\lambda$, the electromotive force of the circuit when the motor is at rest, is the known electromotive force of the battery.

A very simple example of the above formula is afforded, as I have shown, by the observation of the rotation of the pole of a magnet round an electrode.—*Annalen der Physik und Chemie*, 1883, No. 2.

THE TELEPHONE: ITS COMMERCIAL POSITION.†

[A COMMUNICATION.]

IT is generally admitted that the telephone is a useful invention, and many of those who have adopted its use for business purposes say they would not now dispense with it. Why is it, then, that its use is so limited in England?

In seeking a solution of this question the only source from which any information can be had is the official documents of the United Telephone Company.

The nominal capital of this company is £500,000, of which £400,000 was paid up. Of this last amount there was expended for patents about £300,000, and those patents will expire in 1890-91, at which time this £300,000 will be irrecoverably lost, unless the average annual earnings of the company shall permit it to lay aside annually a sinking fund of £37,500. According to the official report of the directors, published in August last, the working expenses for the year absorbed one-half of the income, and the other half allowed a dividend of 5 per cent. with a surplus of £1,945. It is, then, necessary for this company to earn annually £87,500 in order to pay a dividend of 5 per cent. and lay aside a sinking fund to replace its sunk capital of £300,000.

These official statistics afford the key to the solution of the question why the use of the telephone is so limited in England.

It is evident that the cause of its very limited adoption is the high price charged for its use. The United Telephone Company, which has hitherto had a monopoly of the telephone business—if we except the Post-office—is accused, I think unjustly, of using its monopoly to the injury of the public by charging such high prices. In my humble opinion every one, who will without prejudice examine into the finances of this company as set forth in the annual reports of the faithful directors, must admit that the directors have a Herculean task before them to earn £87,500 annually. The unjust complaint is made against them that they refuse to sell their instruments, but only let them on hire at an annual rent of at least double their cost. It appears from the above-mentioned statistics that this way of carrying on their business is the only one in which they could faintly hope to realise one-tenth part of their sunk capital. Rent their instruments they must for the most they can get, for if they should sell them, say, at £6 each, which would give them a profit of £4 each, it would be necessary to sell within eight years 115,000 instruments so as to recoup the £300,000 capital sunk in patents and 160,000 to pay 5 per cent. interest on £400,000 for eight years. To accomplish such a result it would be necessary to sell 14,375 instruments annually at £6 each. The most sanguine inventor (and who more sanguine than an inventor?) would not indulge such a wild dream.

The course adopted by the directors in renting their instruments is the only one which the financial position of their company justified.

Another line of action adopted and vigorously pursued by them (which, to say the least, is questionable) is their attempted intimidation by threats of legal proceedings against almost all persons who presume to make or sell any form of telephone unless under licence from them. This may eventually be a dangerous course for them to pursue, but I suppose they act on the principle that in war all things are fair, and fair or otherwise they seem determined to maintain their monopoly and its consequent high prices; and the public must patiently submit either to pay their high charges or forbear the use of the telephone unless some one, more daring than the rest, will offer to the public, at moderate prices, a telephone equal to the Bell telephone, and not an infringement of Bell's patent.

Is any one prepared to compete with this monopoly? I doubt whether any person will venture, unless he be prepared with good instruments free from any patents owned by the United Telephone Company, and backed by a long purse, so as to carry that company through all the Chancery courts up to the House of Lords.

Is the public, then, to submit to this monopoly for eight more years? No; the public is the master; the public is powerful; the public is rich. Let but the public say the word and the monopoly is doomed, and cheap telephony will be established throughout the length and breadth of the land, and the promoters thereof cannot fail to earn large dividends. The public has the money, let it but show its willingness; telephone instruments superior to any owned by the United Telephone Company, and entirely free from their patents, are in existence, and I have no doubt the letters patent for them could be purchased for less than one-tenth the price paid by this company for their patents. I know of several telephone instruments which are vastly superior to Bell's or Gower-Bell's, and which are entirely free from the patents issued by the United Telephone Company. I forbear to name them, because it is not for me to use your columns to advertise other people's wares.

Das Telephon.

French Newspaper Enterprise.—The *Réforme* has hired a direct wire from London to Paris. The instruments are in the Paris and London offices of the paper, so that transmission is instantaneous. According to circumstances, the Calais, Boulogne, or Dieppe cable will be used; and it is remarked that contrary to expectation the Dieppe cable is the best of the three. The apparatus used is the ordinary Hughes.

* Clausius, Mechan. Wärmetheorie, 2, p. 151.

† [A former contribution from "Das Telephon" appeared in our columns for January 6th. We know of several telephonic instruments clear of the patents named, but we should be glad to receive information concerning the *vastly* superior apparatus. Concerning present telephonic business, see Advt., p. 14.—EDS. ELEC. REV.]

"THE EFFECTS OF TEMPERATURE ON THE ELECTROMOTIVE FORCE AND RESISTANCE OF BATTERIES." *

By WILLIAM HENRY PREECE.

IT is well known that heat influences the conditions of galvanic elements so as to vary the strength of the currents generated by them in those parts of the circuits connecting their poles.

In 1840 De la Rive † found that the action of a galvanic pair was accelerated when it was put into hot fluid instead of cold fluid, and he attributed the result to increased chemical affinity.

Faraday ‡ repeated De la Rive's experiment, but he, on the other hand, attributed the result to improved conductivity in the liquid and he showed that the effect was not due either to motion, to chemical action, or to thermo-electric action, or indeed to any increase in the electromotive force.

Daniell, § also, found an increased current due to increased temperature. According to him, one of his elements was nearly trebled in strength when raised to 212° F. He attributed the effect to the increased energy of the affinity. Said he, "Changes of temperature even have a marked influence upon the working of the voltaic battery, and must not be neglected in nice comparative experiments."

J. B. Cooke ‖ made careful observations on the chemical affinity in a galvanic cell, and indicated the error due to changes of temperature, but he remarked, "These affinities do not appear to be affected by any changes of temperature between ranges of 50° and 212° F."

Crova investigated the effects of heat on the electromotive force alone, and he showed (1) that the electromotive force of a Daniell's element decreases regularly with an increase of temperature; (2) that the electromotive force of a Grove's element increases with temperature; (3) that the electromotive force of a single-fluid element of the Smee type is independent of the variation of temperature.

In 1862 Mr. James Dixon took advantage of the influence of heat to take out a patent for hot batteries, and he suggested the employment of these batteries for the production of the electric light.

In the same year (1862) Lindig ¶ indicated a variation with changes of temperature.

In 1870 Bleekrode ** made some further experiments in the same direction.

In 1872 Mr. Latimer Clark †† showed that the electromotive force of his standard cell varied inversely with temperature about ·06 per cent. for each degree Centigrade.

In 1881 Herwig ‡‡ investigated the subject carefully and showed that polarisation diminishes with temperature. He found that resistance decreased markedly with temperature, and that this was more evident with small electromotive forces than with powerful electromotive forces.

In 1878 the author §§ in investigating the peculiar action of Byrne's pneumatic battery showed that its exceptional power was due to an abnormal formation of heat in its interior, and that this acted, principally, in reducing the internal resistance.

As bearing indirectly also upon this question it should be noted that Becquerel, Paalzow, and Kohlrausch and Nippoldt examined the influence of heat upon the resistance of electrolytes, and showed that it invariably diminishes as the temperature rose. This was determined by them for various solutions.

Now it is to be observed that in all these inquiries no one has quantitatively separated the influence of temperature upon electromotive force from its influence upon internal resistance. It is quite evident from an examination of Ohm's law that the variation in the strength of current can be the result either of a variation in the electromotive force alone or in a variation of the resistance alone, or in an unequal variation of both together. The numerous discrepancies that have been made in the measurements of the behaviour of the Daniell's cell, as well as the erratic performance of batteries used for telegraphic purposes in various exposed positions, have long attracted the attention of the author to the necessity of a more careful inquiry into this matter than has been made hitherto. In fact, all the observations that have hitherto been made are positively useless, from the simple fact that no record has been kept of the independent variations of the internal resistance and the electromotive force in any measurable or comparable manner.

Special apparatus was made, and the following method of experimenting was decided upon.

The cell to be experimented upon was placed inside a cylindrical copper vessel about 10 inches high and about 8 inches diameter; water was poured into the vessel to within an inch of the top of the cell, and the lid of the vessel was put on.

This lid had four holes, two (insulated from the rest of the vessel) to receive the electrodes of the cell, and the other two to allow thermometers to be plunged into the liquid or liquids in the cell without removing the cover or lid. The water in the vessel and the cell in the water were then heated by means of a gas-burner placed underneath the vessel, and the electromotive force and the resistance of the cell were determined at various stages of the heating; while the temperature of the cell was observed at the time of each experiment, the liquid or liquids in the cell were stirred up from time to time so as to obtain, as far as possible, the true temperature of the cell.

The cells experimented upon were the Daniell, bichromate, and Leclanché; those in general use, especially for telegraph purposes.

The Daniell cell consists of a porous pot, containing a solution of copper sulphate, and placed in a stoneware vessel, containing a solution of zinc sulphate. In the porous pot is immersed a copper plate, bent so as to form a hollow cylinder, to which is soldered a copper wire, which constitutes one pole of the cell. A zinc plate, also bent into a cylindrical form, is placed in the outer cell, and has a copper wire soldered to it, constituting the other pole of the cell. The zinc is not amalgamated.

Two forms of the bichromate cell were experimented on, the one being that known as Fuller's bichromate cell, and the other that known as single-fluid bichromate cell. The double-fluid cell (Fuller's) consists of a stoneware jar of a quart size. Inside this is placed a porous pot, in which the zinc is placed; the negative plate, which is of carbon, is placed in the outer jar; the zinc is of peculiar shape, shown in the figure. It is cast on a stout copper wire, and both are well amalgamated. The plate is surmounted by a terminal, as shown. In the outer jar is placed 3 ozs. of bichromate of potassium and 4 ozs. of sulphuric acid. In the inner pot is placed 2 ozs. of mercury. Both are then filled up to within 2 inches of the top with a weak acid solution (one part of sulphuric acid to nine parts of water).

The single-fluid bichromate cell is no more than the cell just described, in which are placed nothing but a rod of amalgamated zinc and a plate of carbon, each forming a pole of the cell.

The Leclanché cell is made thus:—Into a glass jar a solution of the ordinary commercial sal-ammoniac is poured. A zinc rod or plate, into which a connecting tinned iron wire has been cast, is then placed in the solution, and a plate of carbon, surrounded by a mixture of broken gas-carbon or coke and peroxide of manganese, is fixed in a small porous pot at the top of the jar. To make an attachment for the terminal, the top of the carbon plate is capped with lead, which makes good contact with the carbon, and is not liable to be attacked by ammonia. The carbon plate is then dipped in melted paraffine, to fill up its pores and to check the ascension of the liquid by capillary action. Lastly, the wire, the top of the zinc rod, and the lead cap of the carbon plate are covered with pitch, ozokerit, marine glue, or some other compound to protect them from local action.

The results of the experiments are given in the tables below, in which the electromotive force (e) is given in terms of that of a Daniell cell (a standard cell) in good order and at about 14° C., and the resistance is given in B.A. units. The experiments were conducted for me by Mr. R. Shida with great care and patience. Of the Tables I., II., and III., which contain the results of the experiments on the Daniell cell, the first two tables refer to the case where the solution of copper sulphate was saturated at all temperatures (that is to say, the crystals of copper sulphate were always present in the solution) and the solution of zinc sulphate was kept the same, or nearly the same, in strength (that is, the solution was saturated at about 14° C.), Table III. refers to the case where both copper sulphate and zinc sulphate solutions were kept unaltered or nearly so in strength during the experiment (that is to say, they were both saturated at about 10° C.). Table IV. contains the results for the double-fluid bichromate; Table V. those for the single-fluid bichromate; and Table VI. those for the Leclanché.

(1.) As regards the electromotive force. (*a*) *The Daniell Cell.*—Tables I., II., and III. show that, as the cell was heated up from a comparatively low temperature to a higher and higher temperature, the electromotive force of the Daniell cell decreased rather abruptly at first, but more gradually afterwards, until, at a certain temperature it began to increase and continued to do so till the temperature attained that of the boiling point of water; but that (which is rather singular) the electromotive force remained unaltered, or nearly so, while the cell was being cooled down from 100° C. to a lower and lower temperature. These peculiar results (together with the fact that whereas the temperature of the zinc cell rose faster than that of the copper cell while being heated up, the former cooled faster than the latter while cooled down from a high temperature (say, 100° C.), tend to indicate that the diminution in the electromotive force of the cell at the beginning of the experiment was greatly, if not chiefly, due to the thermo-electric action which must have been set up in the circuit.

(*b*) *The Bichromate Cell.*—It will be seen from the Tables IV. and V. that the electromotive force of the bichromate (both the double-fluid and the single-fluid cell), diminished regularly when the temperature was made higher and higher, and increased regularly when the temperature was made lower and lower. The regular diminution by rise and regular augmentation by fall of temperature of the electromotive force (at least when the range of temperature was between 0° C. and 100° C.), was very much greater in the case of the single-fluid bichromate than in the case of the double-fluid bichromate. In the case of the first, the electromotive force at 100° C. was as much as about 6 per cent. lower than that at about 14° C.; whereas in the case of the second, the electromotive force at 100° C. was only about 1·6 per cent. lower than at 19° C.

(*c*) The table VI. shows that the electromotive force of the Leclanché varied when the temperature was varied, so slightly, if at all, that it was difficult to observe the variation by the method used.

(2.) *The Internal Resistance.*—The results obtained for the resistances of the various kinds of cells are more striking and more interesting than those for the electromotive force, as will be quite evident from the tables. They will, however, be understood more readily from the graphical representations of the results by means of curves (in the Diagrams I., II., and III.) in which the abscissæ are proportional to the resistances in B A units, and the ordinates to the temperatures in degrees Centigrade.

* Read before Royal Society; received Feb. 8th, 1883.
† "Ann. Chem.," 1828, XXXVII., p. 242.
‡ "Researches," 17th Series, §§ 1925-26.
§ "Chemical Philosophy," p. 506.
‖ "Phil. Mag.," 1861, p. 95.
¶ "Phil. Mag.," 1865, I., p. 408.
** "Phil. Mag.," 1870, p. 310.
†† "Phil. Trans.," 1873.
‡‡ "Ann. Phys.," B. XI., H. 4, No. 12, p. 661.
§§ "Proc. Soc. Telegraph Engineers," 1878.

TABLE I.—Daniell Cell.—Zinc sulphate solution saturated at about 14° C., and copper sulphate solution saturated at all temperatures.

Time.		Temperature.			D.	d.	d′.	r.	e.	b.	Remarks.
Date.	Hour.	Copper sulphate solution.	Mean.	Zinc sulphate solution.							
Dec. 9	11 A.M.	13° C.	13° C.	13° C.	288	288	119	3	1·000	2·12	Heating commenced.
		26	23	20	,,	285	94	,,	·990	1·48	
		40	33	26	,,	285	81	,,	·990	1·19	
		52	43·5	35	,,	285	70	,,	·990	·98	
		64	56·5	49	,,	285·5	61	,,	·991	·82	
		78	71·5	65	,,	286·5	56	,,	·995	·73	
		84	79·5	75	,,	286·5	54	,,	·995	·70	
		86	83	80	,,	286·5	53	,,	·995	·68	
		89	86	83	,,	286·5	53	,,	·995	·68	
		98	95·5	93	,,	287	52	,,	·996	·66	
		100	100	100	,,	287	52	,,	·997	·66	Heating stopped.
		95	95·5	96	,,	288	58	,,	1·000	·76	
		90	90·5	91	,,	288	62	,,	1·000	·82	
		80	81·5	83	,,	288	68	,,	1·000	·93	
		70	70·5	71	,,	288	76	,,	1·000	1·08	Hot water removed and cold water poured in the vessel.
		60	60	60	,,	288	88	,,	1·000	1·32	
		47	47	47	,,	288	104	,,	1·000	1·70	
		35	35	35	,,	288	122	,,	1·000	2·20	
Dec. 9	7 P.M.	25	25	25	,,	288	134	,,	1·000	2·61	Experiments stopped and everything left undisturbed till the morning of the 11th.
Dec. 11	10.30 A.M.	11	11	11	288	288	122	,,	1·000	2·18	

N.B.—If E and e be the electromotive force of the standard cell and the cell examined respectively, and b the resistance of the latter cell,

Then $$e = E \times \frac{d}{D}, \qquad b = r \times \frac{d'}{d - d'}.$$

TABLE II.—Daniell Cell.—Zinc sulphate solution saturated at 14° C., and copper sulphate solution kept saturated at all temperatures.

Time.		Temperature.			D.	d.	d′.	r.	e.	b.	Remarks.
Date.	Hour.	Copper sulphate solution.	Mean.	Zinc. sulphate solution.							
Dec. 11	10.30 A.M.	11° C.	11° C.	11° C.	288	288	122	3	1·000	2·18	Heating commenced.
		25	22	19	,,	285	94	,,	·989	1·48	
		36	31	26	,,	284·5	82	,,	·988	1·21	
		48	42	36	,,	285	72	,,	·989	1·01	
		56	50	44	,,	285·5	66	,,	·991	·92	
		68	61·5	55	,,	286	59	,,	·993	·78	
		78	71·5	65	,,	287	54	,,	·996	·70	
		88	84	80	,,	287	53	,,	·996	·68	
		96	93·5	91	,,	288	52	,,	1·000	·66	
		99	98	97	,,	288	52	,,	1·000	·66	Heating stopped, lid of vessel taken off, hot water removed and cold water poured in.
		95	95·5	96	289	289	54	,,	1·000	·68	
		91	92	93	,,	289	58	,,	1·000	·75	
		82	83	84	,,	289	66	,,	1·000	·89	
		71	72	73	,,	289	73	,,	1·000	1·01	
		59	61	63	,,	289	84	,,	1·000	1·23	
		50	50·5	51	,,	289	95	,,	1·000	1·47	
		41·5	42	42·5	,,	289	106	,,	1·000	1·74	
		30	30·5	31	,,	289	124	,,	1·000	2·25	
		21	22	23	,,	289	134	,,	1·000	2·60	
		17	18	19	,,	289	141	,,	1·000	2·86	
Dec. 11	7.15 P.M.	13	13	13	,,	289	149	,,	1·000	3·19	Experiment stopped and everything left undisturbed till next morning
Dec. 12	11.40 A.M.	12	12	12	,,	289	123	,,	1·000	2·22	Cooling by means of ice commenced
		6	7	8	,,	289	136	,,	1·000	2·66	
		3	4	5	,,	288	142	,,	·996	2·90	
,,	1 P.M.	2	2	2	,,	288	146	,,	·996	3·06	

TABLE III.—Daniell Cell.—Both zinc sulphate and copper sulphate solution very nearly saturated at about 10° C.

Time.		Temperature.			D.	d.	d′.	r.	e.	b.	Remarks.
Date.	Hour.	Copper sulphate solution.	Mean.	Zinc sulphate solution.							
Dec. 19.	1 P.M.	7° C.	9° C.	11° C.	227	227	108	3	1·000	2·72	Cooling by ice and salt commenced.
		3	4	5	,,	227	117	,,	1·000	3·19	
	3.15 P.M.	0	0	0	,,	227	123	,,	1·000	3·55	Experiment stopped.
					232	232	98	,,	1·000	2·19	
Dec. 20.	10.20 A.M.	17	17	17	232	232	98	,,	1·000	2·19	Commenced heating.
		34	28	22	,,	230	80	,,	·991	1·60	
		52	45	38	,,	229	63	,,	·987	1·14	
		70	63	56	,,	229	54	,,	·987	·93	
		84	79	74	,,	230	53	,,	·991	·90	
		93	91	89	,,	230	52	,,	·991	·88	
	2.0 P.M.	99	98	97	,,	230	52	,,	·991	·88	Stopped heating.
		86	84	82	,,	231	56	,,	·996	·96	
		55	60	65	,,	232	82	,,	1·000	1·64	
		35	39	43	,,	332	104	,,	1·000	2·44	
		20	21	22	,,	232	126	,,	1·000	3·57	
	6.40 P.M.	17	17	17	,,	232	130	,,	1·000	3·87	Experiments stopped and everything left undisturbed till next day.
Dec. 21.	11 A.M.	17	17	17	232	232	106	,,	1·000	2·52	

TABLE IV.—Double-fluid Bichromate Cell.

Time.		Temperature.			D.	*d*.	*d'*.	*r*.	*e*.	*b*.	Remarks.
Date.	Hour.	Carbon cell.	Mean.	Zinc cell.							
Dec. 14.	11.10 A.M.	14° C.	14° C.	14° C.	222	429	219	1	1·932	1·04	Heating commenced.
		23	25	27	,,	426	208	,,	1·919	·95	
		48	43	38	,,	425	195	,,	1·914	·85	
		62	59	56	,,	424	188	,,	1·910	·80	
		79	74	69	,,	423	180	,,	1·905	·74	
		84	81	78	,,	423	177	,,	1·905	·72	
		92	88	86	,,	423	172	,,	1·905	·69	
		98	97	96	,,	423	168	,,	1·905	·66	Heating stopped.
		84	83	82	,,	423	174	,,	1·905	·70	
		52	59	66	,,	425	182	,,	1·914	·75	
		41	45	47	,,	426	194	,,	1·919	·84	
Dec. 14.	5.15 P.M.	25	27	29	,,	428	208	,,	1·928	·95	Experiments stopped and everything left undisturbed till December 16th.
Dec. 16.	10.20 P.M.	17	17	17	,,	429	217	,,	1·932	1·02	
		14	14	14	,,	429	219	,,	1·932	1·04	
		6	7	8	,,	429	229	,,	1·932	1·14	Process of cooling by ice commenced.
		4	4·5	5	,,	429	234	,,	1·932	1·20	
Dec. 16.	2 P.M.	2·5	3	3·5	,,	429	237	,,	1·932	1·23	

TABLE V.—Single-fluid Bichromate Cell.

Time.		Temperature of the Cell.	D.	*d*.	*d'*.	*r*.	*e*.	*b*.	Remarks.
Date.	Hour.								
Dec. 28.	10.50 A.M.	19° C.	212	408	190	1	1·924	·87	Heating commenced.
		29	,,	405	182	,,	1·910	·81	
		40	,,	404	177	,,	1·906	·75	
		56	,,	403	167	,,	1·901	·71	
		74	,,	398	156	,,	1·878	·66	
		87	,,	392	140	,,	1·849	·59	
		92	,,	386	131	,,	1·820	·51	
		96	,,	384	128	,,	1·810	·50	Heating stopped.
		83	,,	388	135	,,	1·830	·53	
		74	,,	392	140	,,	1·849	·56	
		60	,,	397	152	,,	1·872	·62	
		42	,,	404	169	,,	1·906	·72	
		17	,,	408	184	,,	1·924	·82	Cooling by ice commenced.
		10	,,	408	196	,,	1·924	·92	
		2	,,	408	222	,,	1·924	1·11	

TABLE VI.—Leclanché Cell.

Time.		Temperature.			D.	*d*.	*d'*.	*r*.	*e*.	*b*.	Remarks.
Date.	Hour.	Zinc cell.	Mean.	Carbon cell.							
Dec. 18	10.45 A.M.	14° C.	14° C.	14° C.	227	312	146	1	1·375	·87	
		22	20	18	,,	312	142	,,	1·375	·84	Heating commenced.
		40	36	32	,,	312	134	,,	1·375	·75	
		60	57	54	,,	312	120	,,	1·375	·63	
		76	73	70	,,	312	116	,,	1·375	·59	
		87	84·5	82	,,	312	112	,,	1·375	·56	
		92	89	86	,,	312	110	,,	1·375	·54	
		94	91	88	,,	312	108	,,	1·375	·53	
		97	95	93	,,	312	106	,,	1·375	·51	Heating stopped.
		80	83	86	,,	314	110	,,	1·383	·54	
		52	56	60	,,	313	124	,,	1·379	·66	
		34	35	36	,,	312	136	,,	1·375	·77	
Dec. 18	6.15 P.M.	20	21	22	,,	312	145	,,	1·375	·87	Stopped observations and everything left undisturbed till next day.
Dec. 19	11 A.M.	15	15	15	,,	312	148	,,	1·375	·90	
		8	9	10	,,	313	154	,,	1·379	·97	Process of cooling by ice and salt commenced.
		3	4	5	,,	312	158	,,	1·375	1·03	
		0	0	0	,,	312	164	,,	1·375	1·10	

(*a*) *The Daniell Cell.*—The curves in the Diagram I. represent the results for the Daniell, the curve, A B C D E, corresponding to the case (Table II.) in which the copper sulphate solution was kept saturated at all temperatures, while the zinc sulphate solution was kept constant in strength, and the curve, *a b c d e*, corresponding to the case (Table III.) in which both solutions were kept unaltered in strength during the experiments. The directions of the arrows indicate the order of the experiments. For instance, in the curve, A B C D E, the portion A B represents the result obtained while the cell was being heated up from about 11° C. to nearly the boiling point of water, the portion B C, that obtained while the cell thus heated up was being cooled down from 100° C. to about 12° C.; and, lastly, the portion, D E, that obtained in cooling the cell from 12° C. to nearly so low a temperature as the freezing point of water. A very similar explanation applies to the curve, *a b c d e*.

The results thus laid down by means of the curves, A B C D E and *a b c d e*, present many points of interest. These curves clearly show:—

1°. That when a Daniell cell is heated from a low temperature, say, 0° C., up to a high temperature, say, 100° C., the resistance of the cell decreases rather abruptly at first, but more gradually afterwards, falling from 2·12 to ·66 ohms, or more than one-third.

2°. That when the cell thus heated up is cooled down, the resistance increases, but increases in a greater rate than it decreased while

being heated; in other words, the resistance of a Daniell cell at any temperature (at least between 0° C. and 100° C.) is smaller before it is heated up to a high temperature than afterwards, provided the heating and cooling be done not very slowly.

3°. That if the cell thus cooled down be left undisturbed at a certain temperature, the resistance of the cell gets less and less, till, at last, at the end of a certain period (which will be from about 40 to 50 hours) it gets down to the value which it had before being heated up at all.

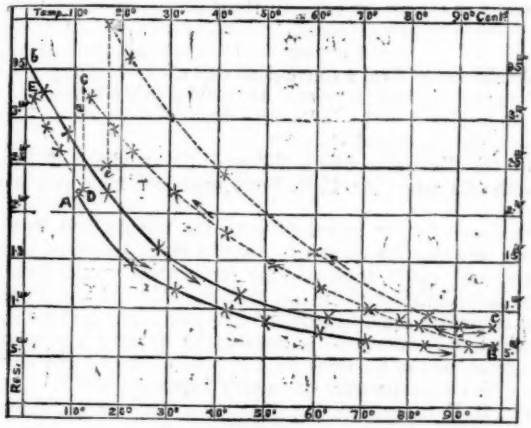

FIG. 1.

4°. And, lastly, that the resistance of a Daniell cell is considerably less when the solution of the copper sulphate is more concentrated than when it is less concentrated, at any temperature, and under otherwise exactly similar circumstances.

(*b*) *The Bichromate Cell.*—The results for the bichromate are not quite so remarkable, nor are they so interesting as those for the Daniell cell, as will be seen on comparing the curves in the Diagram I. with those in the Diagram II., but the fall of resistance is nevertheless very striking. In the case of the double-fluid bichromate, the curve H K of resistance obtained while the cell was being heated up, differs so slightly from the curve K L obtained while it was being cooled down, that the one is hardly distinguishable from the other. The differences in fact may be attributed more to errors of observation than to anything else. Yet if there should be any difference in the resistance in the two cases, it is one opposite in character to that found in the case of the Daniell cell.

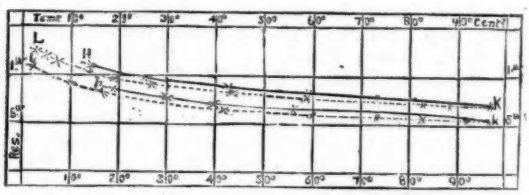

FIG. 2.

The probability of the existence of this difference, as indicated by the curve H K L, is supported by the results shown by means of the curve *h l k*) for the single-fluid bichromate cell. Every point of the portion *h k* of the curve obtained while heating the cell up, lies considerably higher than the corresponding point in the portion *k l* obtained while cooling it down; that is to say, the resistance of the single-fluid bichromate cell at any temperature is greater before than after it has been heated up.

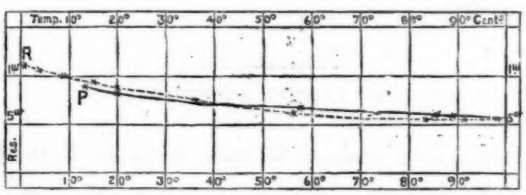

FIG. 3.

(*c*) Very little remains to be said of the curve P Q R in the Diagram III., which represents the results for the Lelanché cell. The general character of the curve P Q R bears a strong resemblance to the curve H K L; in other words, the resistance of the Leclanché diminishes with the rise and increases with the fall of temperature in nearly the same rate as the resistance of the double-fluid bichromate cell does. And, moreover, it is a matter of difficulty to say with certainty, in the case of the Leclanché as in the case of the double-fluid bichromate, whether or not the curve of resistance obtained while being heated up coincides with the curve of resistance obtained while being cooled down, because the part R Q is so nearly coincident with the part P Q of the curve P Q R, that any slight errors in the observations may have caused the non-coincidence between the two parts.

It follows from these experiments that changes of temperature do not practically affect electromotive forces, but that they materially affect the internal resistances of cells. Faraday's observation is fully confirmed, while Daniell's mistake is easily understood if he employed, as he probably did, a galvanometer of low resistance.

It also follows that of the various forms of batteries in practical use the Daniell is most seriously influenced by variations in temperature, and that in all experiments with that battery, either the temperature must be kept constant, or frequent measurements should be taken of its internal resistance, and allowances made for the variation.

[The electromotive forces of the batteries under test were measured by the condenser method, the discharges being compared with that from a Daniell cell. The internal resistances were measured by Munro's arrangement (see ELECTRICAL REVIEW for Feb. 1st, 1878), which allows of the tests being made with great accuracy, since no error due to polarisation can result.—EDS. ELEC. REV.]

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph Engineers and of Electricians.

AN ordinary general meeting of this Society was held on Thursday, February 22nd, Mr. WILLOUGHBY SMITH, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members read, Mr. A. J. S. ADAMS replied to the criticisms on his paper read at the last meeting of the Society.

A paper was then read by Mr. J. N. SHOOLBRED, B.A., on "The Measurement of Electricity for Commercial Purposes." The author commenced his paper by saying that his remarks were intended to deal more especially with the commercial question raised by what is termed the "supply of electricity" in the Electric Lighting Act, 1882. The evaluation of the electrical energy of the supply depends upon the exact measurement of the factors, the amount of the supply, and the pressure under which it is given, or, in other words, the quantity of the current, and the difference of potential (or electromotive force) which the consumer is able to avail himself of. To arrive at a due evaluation of the supply of electric energy, the measurement of the two factors, volts and ampères, must be effected either separately or combined; and also a continuous and cumulative record must be kept of the supply as it proceeds.

To measure with completeness for commercial purposes, a supply of electricity will entail, therefore, a continuous record of each of the two elements, pressure and current, either separately or combined. In the supply of towns, however, the question for the consumer, may, and will most probably, be much simplified, by causing one of these elements, that of pressure, to remain constant, since it is very likely that a constant standard pressure of supply will be fixed by the Government in granting the several Provisional Orders. If so, it then becomes the duty of the suppliers to keep up to that pressure under penalty; and instruments for recording such pressure will have to be installed where required, and placed under proper supervision. For the customer, however, it will then generally suffice to have an exact record of the quantity only of his individual consumption of electric supply.

Mr. SHOOLBRED then referred to the various instruments which had been devised for measuring current strength, potential, power, or energy, &c., Most of these instruments have already been referred to in previous numbers of the ELECTRICAL REVIEW. Ayrton and Perry's Erg meter is but a further development or sequel to their power meter, by the addition of apparatus which integrate and record continuously the time during which the electrical energy has been imparted, as well as the variations in its amount. By this means is preserved a record of the entire work done, or of the total electrical energy supplied. As in the power meter, two coils are here made use of. A thick wire one on the main circuit, to measure the amount of current, and a thin wire one on a shunt joining the ends of the main circuit, to measure the difference of potentials or electromotive force of the main circuit. In the arrangement the thin wire coil, of say one 1,000 ohms resistance, simply replaces the pendulum bob of a clock. The wires from each end of the

coils pass up the sides of the pendulum rod and on to binding screws, which can be joined to the supply and return cables of a house, or machine, or a system receiving electrical energy. In the immediate vicinity of the fine wire coil, fixed to the clock case, and parallel with the plane of the pendulum path, is fixed the thick wire coil, which forms part of the main circuit, and has a very small resistance. The effect upon the thin wire coil of its repeated passages in front of the thick wire coil is to cause a certain pull or attraction upon its motion—either of acceleration or of retardation, according to the direction of the coiling. This acting, in addition to the ordinary action of gravity upon the pendulum, will keep constantly adding to, or retarding, its rate of motion in proportion to the electrical power of the circuit. This pull is the product of the magnetic moments of the two coils, and therefore is proportional to the product of the current and the electromotive force.

The effects of these repeated accelerations or retardations upon the progress of the clock keep constantly accumulating, and their total amount can at any time be detected and ascertained by observing the amount of loss or gain which the clock has experienced. As the rate of loss or gain in the clock due to different amounts of electrical power has been previously ascertained, this knowledge of the total retardation or acceleration upon the clock is, in fact, a record of the total amount of electricity energy which has been expended, or of the work done, since the last observation of the clock. It is probable that the supply of electricity in a town will be carried out at a certain defined standard pressure or electromotive force, which will be guaranteed to the consumer; and to assure the fulfilment of this condition special steps will be taken by the local or other authority. The consumer need, therefore, but concern himself, as far as the supply he receives and has to pay for, with the quantity of electricity which he has made use of. In fact, the meter he makes use of to record it may be a coulomb meter. The work or energy meters will not be needed for general application, but only in special cases, where the complete record of the total electrical energy supplied is required. The successive mechanical operations in the meter may be recorded in a cumulative way by the ordinary arrangement of a train of wheels; both in the case of those meters based upon electrolytic action, and causing periodical reversals in the direction of the current, and also in those where the action due to the current is a purely mechanical one. There remains, then, but the question of the mode of graduation of the respective indicating dials. The unit proposed to the Board of Trade in several Provisional Orders, is "the energy in a current of 1,000 ampères with an electromotive force of one volt flowing during one hour," which means 1,000 volt-ampère hours, or 3,600,000 volt-coulombs. As it is probable that one of these factors (the volt) being fixed and constant, may be taken out of the commercial calculation for the consumer, it is worth while considering what dimensions the remaining factor (the coulomb) would assume under the ordinary conditions of practice; and hence what would be most convenient graduation of the dials to embrace these dimensions? But the commercial question requires also a financial expression in which to reckon these dimensions. The money value accompanying the suggestion of the above 1,000 volt-ampère hours unit, and which is sought to be attached primarily to 100 of these units, is in some Provisional Orders 70s., in others 75s. Assuming the money value for 100 units of 1,000 volt-ampère-hours each to be 70s., we have the following table :—

E. M. F. Volts.	PRICE.			
	100 Coulombs.	10,000 Coulombs.	100,000 Coulombs.	1,000,000 Coulombs.
	Pence.	Pence.	s. d.	£ s. d.
100	·23	2·33	1 11·3	0 19 5
110	·26	2·57	2 1·7	1 1 5
120	·28	2·8	2 4	1 3 4
130	·3	3·03	2 6·3	1 5 3
140	·32	3·27	2 8·7	1 7 3
150	·35	3·5	2 11	1 9 2
160	·37	3·73	3 1·3	1 11 1
170	·4	3·97	3 3·7	1 13 1
180	·42	4·2	3 6	1 15 0
190	·44	4·43	3 8·3	1 16 11
200	·46	4·67	3 10·7	1 18 11

The prices in this table are based on the assumption that the price per coulomb unit remains at the same rate, irrespective of the intensity of the electromotive force. As a matter of fact, the amount of the latter ought certainly to be taken into account in fixing the sale price. Thus, with a pressure at 200 volts, the price for a certain number of coulombs ought not to exceed two-thirds of that of the same supply at 100 volts of pressure, in consequence of the economy in the former case, in the distributing mains, and in general working expenses. From a careful consideration of this table it would appear that the amount of 100,000 coulombs would form a convenient unit of value whereby to reckon the commercial price. It would also serve as a basis of graduation for the indicating dials of the meters, with subdivisions to $\frac{1}{10}$ and $\frac{1}{100}$ parts.

In the discussion which followed the reading of Mr. Shoolbred's paper, Mr. C. V. BOYS explained his power and quantity meters.

Professor PERRY, in referring to the Ayrton and Perry meter, said that for the purpose a 30s. clock answered perfectly, and would enable quite as accurate results being given as was the case with gas meters. He did not think that electricity could be supplied like gas. The latter only required to be measured as regards its quantity; pressure was practically of no account; but with electricity the case was different, as pressure was a very important factor.

Mr. R. E. CROMPTON, Mr. J. MUNRO, Mr. FRASER, Major ARMSTRONG, R.E., and Mr. A. SIEMENS also took part in the discussion.

The meeting then adjourned.

Physical Society.—FEBRUARY 10.

Prof. FULLER in the chair.

ANNUAL GENERAL MEETING.

NEW officers elected for the year: President, Prof. R. B. Clifton, M.A., F.R.S.; Vice-Presidents, Sir W. Thomson; Prof. S. C. Foster, F.R.S.; Dr. J. Hopkinson, F.R.S.; Lord Rayleigh, F.R.S.; Prof. W. C. Roberts, F.R.S.: Secretaries, Prof. A. W. Reinold, M.A.; Mr. Walter Baily, M.A.; Treasurer, Dr. E. Atkinson: Demonstrator, Prof. F. Guthrie, F.R.S.: other members of council, Prof. W. S. Adams, M.A., F.R.S.; Prof. W. E. Ayrton, F.R.S.; Mr. Shelford Bidwell, M.A., LL.B.; Mr. W. H. M. Christie, M.A., F.R.S.; Prof. F. Fuller, M.A.; Mr. R. T. Glazebrook, M.A., F.R.S.; Mr. R. J. Lecky, F.R.A.S.: Prof. O. J. Lodge, D.Sc.; Mr. Hugo Müller, Ph.D., F.R.S.; Prof. J. Perry. New member, Prof. Blyth, of Anderson's College, Glasgow.

Prof. SILVANUS P. THOMPSON explained his new graphical method of showing Jacobi's law of maximum rate of working, and Siemens' law of efficiency for dynamo-electric machines. This has been fully explained in the *Philosophical Magazine*, and in the Cantor lectures on Dynamo-electric Machinery, delivered by Prof. Thompson. Prof. W. G. ADAMS pointed out the advantages of a graphic system of the kind.

FEBRUARY 24.

Prof. CLIFTON in the chair.

NEW Members:—Prof. A. W. Scott, M.A., Mr. F. G. M. Page, B.Sc.

Mr. LEWIS WRIGHT read a paper on the "Optical Combinations of Crystalline Films," and illustrated it by experiments. He exhibited the beautiful effects of polarisation of light and the Newtonian retardation by means of plates built up of thin mica films and Canada balsam. The wedges thus formed gave effects superior to those of the more expensive selenite and calcite crystals. The original use of such plates is due to Mr. Fox, but Mr. WRIGHT showed many interesting varieties of them, including what he termed his "optical chromotrope," formed by superposing a concave and a quarter-wave plate on each other. Norenberg's combined mica and selenite plates were also shown.

Mr. SPOTTISWOODE praised the results very highly,

and pointed out their value to the teacher and student, as showing how the effects can be produced step by step. The phenomena can be shown by an addition to the ordinary microscope, costing some two guineas, as made by Messrs. Swift and Sons.

Mr. BRAHAM then gave an "Experimental demonstration of the vorticle theory of the formation of the Solar System," by rotating a drop of castor oil and chloroform in water until it threw off other drops as planets.

WRIGHT AND MACKIE'S MECHANICAL GLASS-BLOWER.

WE gave a description in the ELECTRICAL REVIEW for January 20th of a very ingenious and highly useful machine for blowing the glass bulbs, &c., for incandescence electric lamps. At the same time we promised another article descriptive of a second apparatus designed specially for chemical and physical laboratories, and also of some details connected with the fitting-up of these machines. The machine we now illustrate in elevation, side view and plan, figs. 1, 2, and 3, is constructed somewhat on the same lines as that previously described in our columns. It is operated by a treadle motion, T, worked by foot, and this is connected

FIG. 2.

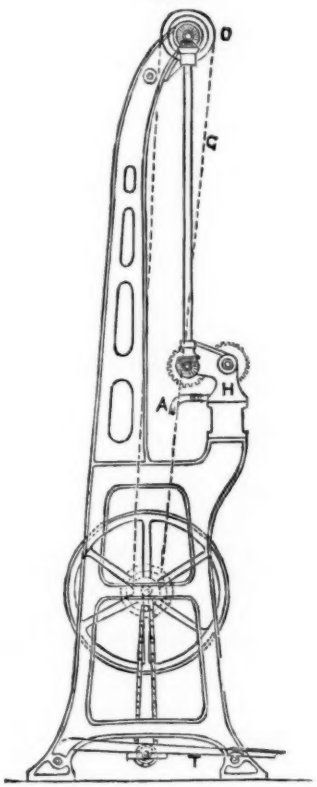

FIG. 1.

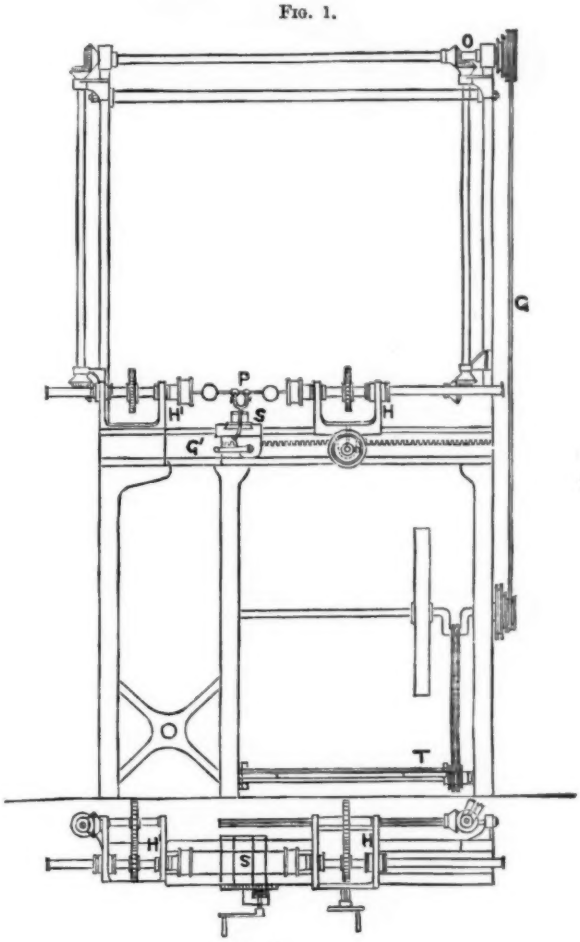

FIG. 3.

by means of the band, G, to the overhead motion, O, which communicates with the headstocks, H and H', the former of which is free to traverse the bed of the machine by means of a pinion and rack actuated by a handle. As now shown in the drawing, it is completing the blowing of two bulbs, the blowpipe being mounted on a saddle, S, but by removing the gap-piece, G', a long length of glass-tube can be operated upon for the formation of T pieces. This arrangement is seen more clearly in fig. 4, where H is the movable headstock with a projecting tube of glass, g, held in the chuck, C^2, about to be attached to the vertical glass tube, g'. H' is the stationary headstock, carrying a tubular chuck, I, provided with sliding clamps, C, C^1, for clamping the vertical glass tube, g'. This being brought into the necessary position, the blowpipe is caused to play upon the centre, and the tube having become heated air is admitted, and

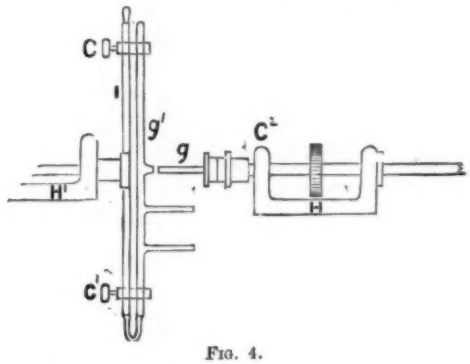

FIG. 4.

a small globular extension is blown out and burst. The flame is then applied to the end of this extension and the glass tube, g, and after being sufficiently heated, the headstock, H, is moved forward to bring the ends of the tubes into contact, air then being admitted to form a regular joint.

Glass tubes and vessels can thus be joined at various angles at the will of the manipulator, in fact, all the requirements of physical laboratories can be easily performed.

Fig. 5 shows the chuck for clamping glass tubes or rods of various sizes. It consists of a pair of dies sliding either inwards or outwards across the main body of the chuck by means of the two eccentric slots. The dies are made of the most suitable metal for dissipating the heat conveyed along the glass tube before it reaches an india-rubber washer which

makes an air-tight joint between the mandril and the glass tube (see our former article in the ELECTRICAL REVIEW for 20th January). This chuck answers the general requirements of tubular work, but clamps, moulds, and tools of various descriptions are used for special purposes, such as

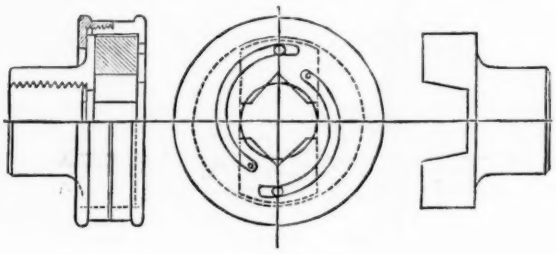

FIG. 5.

sealing in the filaments of incandescence electric lamps, &c.

Fig. 6 is a perspective view of the double or compound blowpipe mentioned in our columns before, and fig. 7 is a section of the same.

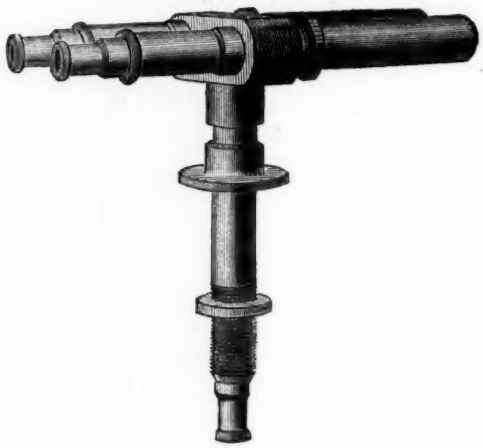

FIG. 6.

The gas is admitted into the vertical tube, G, which leads to a box or annular casing fitted with two or more horizontal tubes with conical nozzles, C. These tubes face other tubes, T, from whence issues the flame. A glass air jet, J, is fixed by means of a cork or stuffing box, as shown, in the tube, C,

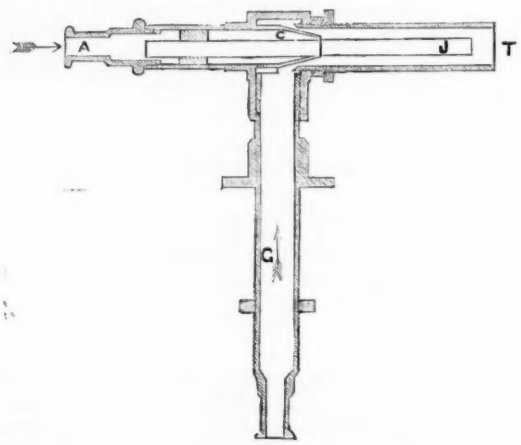

FIG. 7.

the gas being regulated by screwing the tube, T, nearer to or further away from the nozzle of C. This diminishes or increases the cone of heat in relation to the gas and air supply, the latter being admitted at a constant pressure at A.

By the aid of this short description, and that in our former mention of Messrs. Wright and Mackie's apparatus, the reader can form a fair idea of the good and useful work which these gentlemen have accomplished. The machines we have illustrated are not merely experimental, but are perfected and able to perform all that is claimed for them. The inventors have our best wishes for the success and further development of their inventive capacities.

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CORRESPONDENCE.

The Industrial Unit of Electrical Energy.

It seems to me that the difficulty in finding a satisfactory unit to meet the requirements of engineers is still not fully met by the proposals of Mr. Beckingsale or Mr. James Swinburne.

What is required is an actual definite measure of work done by the passage of a given amount of current irrespective of time—that is to say, we are all agreed upon the volt-ohm per second, or ampère. Now, what I suggest is to create a unit which expresses the amount of work done by an ampère current per second of time—namely, an amount of current capable of producing the liberation in its flow of ·0058 cubic centimetres of oxygen, and ·1176 C.C. of hydrogen, or to deposit electrolytically ·0003307 grammes of copper from a solution of a salt of that metal.

To term either of the above measures of work done a Davy, in honour of Sir Humphrey Davy's discovery.

The Davy, then, is a unit of work produced by the flow of an ampère of current, but has the merit of avoiding the question of ampère hours and ampère seconds—that is to say, one Davy may be produced by a current of 1 volt through 1 ohm in 1 second, or 1 volt through 2 ohms in 2 seconds, or 1 volt through 3 ohms in 3 seconds, or 2 volts through 2 ohms in 1 second, or 2 volts through 4 ohms in 2 seconds of time, and so on.

Thus we have a unit of work independent of time, and instead of talking of the ampère hour we should say 3,600 Davys per hour. Having thus established the Davy unit, it can be treated in the same manner as any dynamic unit—that is, 2 Davys per second would have four times the energy of 1, and 3 Davys per second would have nine times the

energy of 1, and 4 Davys per second would have 16 times the energy of 1 when employed in driving a motor.

The Davy, then, becomes not only a useful measure for the amount of current flowing, but it also directly represents the amount of power that can be derived from any given flow of current; and I think, if generally adopted, would avoid an immense amount of ambiguity. If t represents a second of time, D the Davy, E energy, then—

$$D^2 \times t = E.$$

Frederick H. Varley.

Mildmay Park Works,
Mildmay Avenue, Highbury, N.

P.S.—I desire to make a correction in the equation given above, the error in which is obvious. It should read—

$$\frac{D^2}{t^2} = E;$$

and I would like to add, that to convert E into H. P. multiply by R total resistance in circuit, and divide by 745.

It would, perhaps, save confusion to use a monogram, HD, for the Davy. When t^2 = unity, then—

$$\frac{HD \times R}{745} = \text{H. P.}$$

for example.

If 10 Davys per second pass through a resistance of 7·45 ohms, it will equal 1 H. P.

$$10^2 \times 7{\cdot}45 = \frac{745}{745} = 1 \text{ H. P.}$$

This is equivalent to a current of 10 ampères, with a potential of 74·5 volts.

The advantage of this unit is that we have only to determine the value of HD^2, and to find the resistance in circuit, which can be more accurately and readily obtained than the determination of the potential in volts. On these grounds, I think, the Davy will be a practical unit for the electric light and power supplying companies to fix upon for charging the consumer, either for the current delivered, or the same expressed in H. P. value.

F. H. V.

Electric Lighting.

We see in your notice of Mr. Macdonald's lecture, on the occasion of which the hall was lighted with Lane-Fox lamps, you remark that it was the first public exhibition of Incandescent Lighting in Edinboro'. This is not quite correct, as Mr. Partridge, one of our electricians, put in an installation of incandescent lamps a year ago at a lecture given by Prof. Chrystal, at the University in Edinboro'. We may also add that Messrs. Wm. Hope & Son's Chemical Works have been lighted in the same way for some months, and our own works have never been lighted by any other means.

J. E. Jackson,

Manager, Electric Carbon, Storage, and Apparatus Manufacturing Company of Scotland, Limited.

Leith, *February 26th*, 1883.

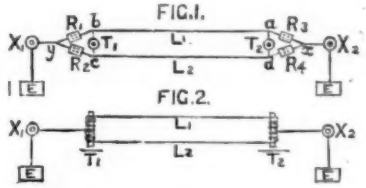
Neutralising Induction.

In reading the last number of your valuable Review I have been pleased to find a description of my two systems for neutralising induction, which you have deemed worthy a space in the columns of your journal, although a slight error occurs in the last paragraph in comparing the second system of mine as identical with Jacob's patented on January 17th, 1882, which I have thought expedient to make clear.

In comparing two things of equal forms but of unequal qualities, or *vice versâ*, not seldom the comparison is liable to errors. As an instance, electric lamps of either class are all based on the principle that electric currents heat their paths, also on the law that temperature at a point in a conductor increases with the reciprocal of the cross-section of that point, likewise by inserting a substance whose power to obstruct the current is greater for a unit length than a similar length of equal cross-section of the other material of which the conductor is made. Although identical in principle, not all the systems of electric lamps in their respective class could be considered alike; consequently, the same may be said for telephone circuits.

With the view to make the matter clear, I have thought it convenient to add the following diagrams:—

Figs. 1 and 2 *prima facie:* they suggest the conclusion that both systems are alike, but on examination these are found to differ considerably in efficiency one from the other.



Both systems regard, in point of economy, the use of the combined line-wires for a second purpose, so that the resistances R_1, R_2, R_3, and R_4, in fig. 1, or the resistances of T_1 and T_2 in fig. 2, are limited. In fig. 1, by following up the various courses of the current generated in either of the two telephones, the efficiency of this system can readily be found.

Starting a current in T_1 towards b, where it divides in an inverse proportion as the resistances of the two circuits, namely, b, y, c and b, a, d, c, the part that circulates in b, y, c is lost, and the other which arrives at a is again split in two branches, namely, a, x, d and a, d, so that the strength of the current which goes through the telephone T_2 is equal to $\frac{R_3 + R_4}{T_2 + R_3 + R_4}$ × by the current that runs in the line-wires.

If we call C the current passing through T_1 and C_4, that passing through T_2 when T_1 is the sender;

$$\text{then } C_4 = \frac{C\,(R_1 + R_2)\,(R_3 + R_4)}{\left(L_1 + L_2 + \frac{T_2\,(R_3 + R_4)}{T_2 + R_3 + R_4} + R_1 + R_2\right)(T_2 + R_3 + R_4)}$$

In this formula we see that the efficiency of this system increases with the resistances R_1, R_2, R_3, and R_4, but as I have said before these resistances are limited when the combined wires are used for a second purpose, consequently by this limitation it renders the telephonic circuit of little use, since this can only be used for very short distances.

It will be seen at a glance that the same does not happen with the system represented by fig. 2, as the strength of the current passing through both telephones which are differentially wound is equal.

In the hope that this letter may find room in the columns of your next issue, I will thank you for the trouble you have taken in so clearly describing and illustrating the two systems in your last number.

A. E. Conti.

London, *February 27th*, 1883.

Electrical Measurements.

The measurement of electromotive force, in terms of a Daniell cell, it seems to me, should be easily and accurately made upon the slide-wire (metre) Wheatstone bridge; but I have not been quite able to accomplish it.

If consistent, will you please tell me how it can best be done, giving a figure of the necessary connections and an example of the work of measuring the E. M. F. of a Leclanché cell?

My bridge is like that mentioned by Mr. Kempe in his handbook.

Samuel Purnell.

San Francisco, California,
February 7th, 1883.

[We do not know of a satisfactory method of comparing electromotive forces by means of the metre bridge.—Eds. Elec. Rev.]

Electric Light Conductors.

The communication from your correspondent "P. C.," under this head, in your issue of the 24th inst., opens up a subject on which there appears to be a good deal of uncertainty. Having my doubts as to the advisability of passing a current of 2,000 ampères through a conductor having a sectional area of one square inch, I endeavoured to obtain a formula which should express the minimum diameter of a wire simply in terms of the current, but I found that there is a great want of experimental data from which to obtain the required constants.

I trust, however, that the following will be of interest, and that your readers will come forward with any additional information they may possess, so that the subject may be well ventilated.

We require, then, a formula for the diameter of a wire in simple terms of the current.

Let us take for this purpose a unit wire 1 foot long and 1-1000 inch diameter (1 mil-foot); our unit of area will be the square foot and our unit of heat 1 grain degree Centigrade.

The radiating surface in square feet of any wire will be—

$$S = l\,d \times \cdot0002618$$

when l is in feet and d in mils; and if K is the quantity of heat radiated per second per square foot by any particular wire, we shall have—

$$Q = l\,d \times \cdot0002618\ K,$$

where Q is the total quantity radiated per second by any given wire.

The quantity of heat generated per second in any copper wire is—

$$H = C^2\,R \times 3\cdot6747,$$

and since for the temperature of the wire to remain constant the heat radiated must exactly balance the heat generated, we have—

$$C^2\,R \times 3\cdot6747 = l\,d \times \cdot0002618\ K.$$

The resistance, R, of a copper wire is—

$$R = \frac{l\ 9\cdot718}{d^2},$$

and by substitution

$$\frac{C^2\,l \times 9\cdot718 \times 3\cdot6747}{d^2} = l\,d \times \cdot0002618\ K,$$

$$\frac{C^2 \times 9\cdot718 \times 3\cdot6747}{\cdot0002618\ K} = d^3,$$

$$\frac{C^2 \times 136400}{K} = d^3,$$

$$d = \sqrt[3]{C^2 \times \frac{136400}{K}},$$

where K is the quantity of heat radiated per square foot per second in grain degrees Centigrade by a copper wire.

It is the experimental values for K in which we possess a very small amount of reliable information. It is well known that the quantity of heat radiated from a given surface is not merely a function of the temperature, but depends, among other things, on the nature of the surface; and the problem is further complicated when the wire is covered with insulating material.

It has been stated by Sir Wm. Thomson that the loss of heat from an unpolished copper surface is about

$$\frac{T - t}{4{,}000}$$

per second per square centimetre in gramme degrees centigrade units, where $T - t$ is the excess of temperature of the wire above the surrounding medium.

Taking, therefore, $T = 48°$ and $t = 13°$, $T - t = 35°$ C.,

and $$\frac{35}{4{,}000} = \cdot00875 \text{ units.}$$

Reducing this to grain degrees per square foot, we have a value for K:—

$$K = 125\cdot44$$

and

$$d = \sqrt[3]{\frac{C^2 \times 136{,}400^*}{125\cdot44}}$$

$$d = \sqrt[3]{C^2} \times 10\cdot283$$

* [Is not the working out of this equation in the next step erroneous?—EDS. ELEC. REV.]

This would give a diameter of 1·632 inches, and a sectional area of 2·092 square inches for a round copper conductor, conveying a current of 2,000 ampères, the conductor being freely exposed to the air.

It is to be noted that in Mr. Fletcher Moulton's regulations nothing is said about a factor of safety. It would appear that the maximum normal current may be 2,000 ampères per square inch of section; but no provision is made beyond the fusible plugs for any excessive current. Would it not be advisable if there is to be such a narrow limit for temperature to add $\frac{1}{10}$th, by weight, to the conductor as a factor of safety?

I trust some of your readers will be able to furnish additional values for K.

W. Kingsland.

Leeds, 26*th February*, 1883.

In reference to an editorial note which we appended to a communication on this subject from a correspondent in our last issue, and in which we expressed a wish that many of our other readers would take up the subject, Mr. Sabine writes us that he for one is at present engaged on experiments with a view to construct such tables as those we alluded to.

Mr. Sabine further says: "In any conductor surrounded by an insulating medium the quantity of heat developed by a current and the quantity of heat emitted must, of course, be equal in equal intervals as soon as the conductor has settled to its higher temperature. The heat emitted per second from the outer surface of a cylindrical lead would be—

$$h\,\Delta t\,l\,D\,\pi,$$

h being the number of heat-units emitted per second, per degree of temperature-difference, and per unit of surface; Δt the difference between the temperature of the surface of the insulator and that of the surroundings; l, the length of the lead; and D, the diameter of the insulator. The heat developed per second in the conductor would be

$$\frac{c^2 r}{J},$$

r being the resistance; c, the current; and J, Joule's equivalent.

$$h\,\Delta t\,l\,D\,\pi = \frac{c^2 r}{J} = \frac{c^2}{J}\,\frac{4\,\rho\,l}{d^2\,\pi},$$

ρ being the resistance of a cube of the unit of length of the conducting wire.

"If the insulating material were in adhesive contact with and sufficiently thin to take the same temperature as the wire, the rise of temperature of the latter corresponding with the current, c, would be—

$$\Delta t = \frac{4\,\rho}{J\,\pi^2}\,\frac{c^2}{h\,d^2\,D}.$$

Assuming, of course, that the insulator conducts the heat through as quickly as its surface can radiate it. Some materials under certain conditions of construction appear to do this very nearly.

"If insulating material be absent, or only in the form of a thin varnish or lamp-black covering, $D = d$ practically, and the rise of temperature becomes—

$$\Delta t = \frac{4\,\rho}{J\,\pi^2}\,\frac{c^2}{h\,d^2}.$$

For a given permissible maximum elevation of temperature the requisite diameter would in this case be—

$$d = \sqrt[3]{\frac{4\,\rho}{J\,h\,\pi^2}\,\frac{c^2}{\Delta t}},$$

all in C.G.S. measure.

"The value of h, which varies with the temperature, has still to be determined for insulating materials. It seems to be dependent upon the condition of the surface as well as upon the material."

[Mr. Beckingsale has requested us not to insert the letter we mentioned last week as arriving too late for publication. —EDS. ELEC. REV.]

NOTES.

Electric Lighting.—The Brush Electric Light and Power Company (Scotland) has just completed the fitting-up of a more powerful engine and a 40-light machine at the Waverley Railway Station, Edinburgh. The result of the change is most marked, and the lighting of the station is universally pronounced a decided success.

The Swan United Electric Light Company has sold to the Russian Government, for £100,000 in cash, the exclusive right to use the company's inventions throughout the empire, and also to sell lamps.

The Model Clauses prepared by the Board of Trade for insertion in Provisional Orders under the Electric Lighting Act are, we understand, now ready for distribution.

M. P. P. Déhéraim, who has been following up Dr. Siemens' experiments on the electric light and vegetation, summarises the results of experiments on plants at the Electrical Exhibition at the Palais d'Industrie in 1881, thus :—(1) The electric arc light emits radiations which are injurious to vegetation. (2) Most of these radiations are arrested by colourless glass. (3) The electric light emits radiations powerful enough to maintain plants in vegetation for two months and a half. (4) The beneficial radiations are not sufficiently powerful to cause the growth of germinating seeds or to allow of the maturation of fruit in older plants.

From America comes the intelligence that the Edison Electric Light Company, in the down-town district, is now lighting 310 houses, wired for 6,225 lamps. The trouble with the engine is overcome and the light now supplied without interruption. The street mains are reported to be as free from leaks as could be expected. The company feels confident that the gas will be supplanted all over the district, and that at the price paid for gas, money can be made.

"Le Magasin du Printemps," one of the largest establishments in Paris, is being fitted up with 340 "Jablochkoff" lamps.

Experiments were made with the Elphinstone and Vincent Dynamo Machine, on the evening of Wednesday, February 21st, at Messrs. Unwin Brothers' printing office, the Gresham Press, Little Bridge Street, Ludgate Hill, in the presence of a large and distinguished company. The guests assembled in a large warehouse on the first floor, along the ceiling of which, and grouped together, were suspended 350 Swan incandescent lamps, each of 20 candle-power. Lord Elphinstone explained that the machine was capable of driving 416 Swan lamps, but owing to delay only 350 could be set up. Mr. Vincent, in a brief address, explained the construction of the machine, remarking that it was the outcome of strictly following Faraday's researches, excluding everything which tended to militate against the conclusions drawn by that eminent philosopher. The dynamo, already fully described in our columns, is claimed to be one of the most powerful continuous current machines ever made, and it is believed that it is destined to take a very important place in the history of electricity. Among other experiments shown, a length of about 40 feet of galvanised iron wire $\frac{1}{8}$-inch thick was rendered red hot, and, the heat still increasing, reached whiteness, and finally the wire fused. Lengths of steel, and also copper wire each became in turn incandescent, the steel being fused. The current was then made to run through a coil of wire immersed in a glass vessel holding three quarts of water, and in half-a-minute the water boiled. The experiments concluded by the lighting up of a very powerful "search light," as used by the navy, the carbons of which are $1\frac{1}{4}$ inches in diameter. This was a brilliant display, far too dazzling to look upon, except with the aid of coloured glass. The whole of the mechanical arrangements were carried out by Mr. Arthur Rigg, engineer to Lord Elphinstone and Mr. Charles W. Vincent, under the superintendence of Mr. S. G. Wilmott, his manager, who also assisted Mr. Vincent with the electrical display.

The Electric Carbon, Storage, and Apparatus Manufacturing Company of Scotland (Limited) intimates, with reference to the petition presented on Saturday for the winding-up of the Electric Carbon Company, that in consequence of a very unfortunate misapprehension it is necessary to explain that the company is in no way connected with that referred to.

At Newington a meeting of the ratepayers was held last week to discuss the proposals of the Newington Vestry to introduce the electric light into the parish, when the following resolutions were adopted :—"That this mass meeting of the working-class ratepayers of the parish of St. Mary, Newington, earnestly protests against the intention of the vestry to introduce the electric light into a limited area of the parish at an enormous cost to the ratepayers; and, furthermore, most emphatically condemns the proposal of the vestry to spend large sums of money on special purposes, without first consulting the ratepayers, more especially at this important crisis in the municipal government of London," and "That this meeting pledges itself to oppose by every means in its power the proposal of the vestry of St. Mary, Newington, on this question of electric lighting, pending the passing of the promised Municipal Reform Bill, and hereby authorises the Workmen's Committee to organise a representative deputation of working-class ratepayers to interview the President of the Board of Trade for the purpose of laying before him the views of the working men of the parish upon this question.

The Newington Vestry met last week, when it was stated that a letter had been received from the Board of Trade acknowledging the Vestry's communication with reference to the application for a licence for the above light, and further stating that the Board of Trade were prepared to entertain the application.

The Lambeth Vestry held their usual weekly meeting on Thursday week, at which it was stated a letter was received from the assistant secretary of the Board of Trade, acknowledging receipt of the objections of the Vestry to the application of the Metropolitan (Brush) Electric Light and Power Company (Limited) for a Provisional Order; and a letter was also received acknowledging receipt of the application of the Vestry for a licence under the Electric Lighting Act.

The Merchants' Alliance Supply Stores, Bath, have been lighted with the electric light, Brush system, by the Great Western Electric Light and Power Company, Limited, under the personal superintendence of Mr. P. Jolin. There are altogether six arc lights, each of 2,000 candle-power, four inside and two outside the premises, one of the latter being placed on the top of the house, and fitted with a "head-light reflector," similar to the reflectors used on the front of the locomotives in the United States, and capable of throwing a ray of light for a half-mile. These lights are supplied by a No. 5 A Brush machine, driven by a 6 horse-power horizontal steam-engine, erected by Messrs. Adlam and Son, of Bristol.

The electric light will be used in the physical section of the new Dundee University.

H.M.S. "Phaeton," launched from the shipbuilding yards of Messrs. R. Napier and Sons, Govan, Glasgow, on Tuesday last, is provided with all the latest improvements, including the electric light.

At Glasgow, on Monday, Messrs. John Elder and Co. launched another fine steamer, built to the order of Messrs. Donald Currie and Co., for the Castle Packet South African service. The "Morham Castle" is magnificently fitted up, and the whole of the entrances, corridors, saloons, and the ladies' boudoir, captain's cabin, chart rooms, engine rooms, &c., are to be lighted by incandescent lamps.

The illumination of the portion of the newly-constructed Holborn Restaurant, forming the frontage of the building which is now nearly finished, is throughout accomplished with Edison's incandescent electric lamps, grouped in "electroliers" of hammered brass, after a Venetian original in the *salon*, and in the staircase of the Louis Seize style, copied from some in the Petit Trianon. These fittings have been designed and supplied by Messrs. Verity and Son, of Covent Garden.

The Chelsea Vestry met on Tuesday, when the report of the surveyor, Mr. Stayton, C.E., was read. It recapitu-

lated what took place before the Board of Trade this day fortnight, congratulated the Vestry at finding the conclusions of the Board agreed with those of the Vestry, and recommended that the new area arranged with the Brush Company be approved. Mr. Charles Mossop, the committee's chairman, moved the adoption of the report. He reminded the Vestry that the scheme of the company was to take for their area of supply the whole parish, and for periods varying from 2½ to 12½ years from the passing of the Act. The Vestry opposed the scheme as regards space and as regards time. The latter was the more important item. Who could tell the value of a single year of electricity? The Vestry had offered a very liberal alternative scheme. They had divided the parish into three blocks—A, B, and C—and the company had accepted block A, the easterly part of the parish. A is divided into two parts, and the smaller part the company had to light within two years and six months. In round numbers this would cost £30,000. The company had to place their plans, specifications, and estimates before the Board of Trade, and if the figures were approved that sum would have to be set aside for this district, and all troubles as to payments for patents are at an end. The area must be agreed to by the Vestry, and the money must be set aside for the second portion as before. This practically got rid of bogus companies, and removed the difficulties as to sub-letting and assigning. The company had given up the clause in the Provisional Order which apparently overrides the Act, and this got rid of the question as to over-head wires, and left the Vestry with the control of their streets. Mr. Stayton's suggestion as to the wires being placed under the footways on each side of the street was accepted. The Board of Trade wished it to be known that they did not desire to interfere with local authorities. The Vestry must decide which of two companies should be preferred, and they must settle with the companies the area of supply. Mr. Culbertson seconded, thanking Mr. Mossop and the surveyor for the great trouble they had taken, and the motion was carried unanimously.

The Northern Electric Light, Power, and Appliances Company (Limited) held their second general meeting in Dundee last week. The report for the period from October 13, 1881, to December 31, 1882, after including a proportion of the preliminary expenses, showed a loss of £264 19s. 6d. The directors regretted that the business of the company had not been commercially profitable, but thought the result not unsatisfactory, regard being had to the difficulties of establishing a new business, and to the special obstacles thrown in the way of the company at its formation. The directors intimated that they would in future do less in temporary hires and more in permanent installations. The report was unanimously adopted.

Dynamo-Electric Machines.—We have recently inspected the "Lumley" machine, which we shall describe fully next week, if possible. The armature of the machine is of the "Pacinotti" type, but the mode of constructing it constitutes its chief feature. All the parts appear to be substantial, and easily made and put together. The workmanship is all that can be desired, both electrically and mechanically, and Messrs. Paterson and Cooper, the well-known electrical engineers and manufacturers, are the makers.

The Library of the Society of Telegraph Engineers and of Electricians.—We understand that Mr. A. J. Frost has arranged to have his catalogue of accessions to the library of the Society of Telegraph Engineers and of Electricians printed with each number of the Society's Journal, instead of leaving it to the end of the year, as at first intended. The additions made during the month of January amount to more than fifty books and pamphlets.

The Society of Telegraph Engineers and of Electricians.—At the next meeting, to be held at 25, Great George Street, on Thursday, March 8th, at 8 p.m., a paper will be read "On some New Forms of Telephone Transmitters, with a Note on the Action of the Microphone," by John Munro, associate.

Type Printing Telegraphs.—The Knudson printing telegraph instrument, described in our last issue, is on exhibition at No. 27, Chancery Lane (Room 11), where it can be seen between 11 and 3 o'clock.

The Telephone in Dundee.—The National Telephone Company (Limited), Dundee, has been instructed by the Dundee Police Commissioners, the Dundee Town Council, and the Dundee Guardians, to make the following connections by telephone :—

Private Lines.—18 wires from the central police station of the Dundee Commissioners to the following 18 stations:—Four branch police stations, chief constable's house, deputy constable's house, police surgeon's house, superintendent's (fire brigade) house, six firemen's houses, gas commissioners' office, water manager's office, police clerk's office, Stratton's stables. Three wires from the water manager's office to the following stations:—Water manager's house, keeper's house (Stobsmuir reservoir), keeper's house (Clepington reservoir). Police clerk's office to borough engineer's office. For Board of Guardians.—Three connections with exchange, workhouses, and the parochial office.

Exchange Lines.—16 wires from the central exchange of the company, 13, Panmure Street, to the following 16 stations:—Town clerk's office, police treasurer's office, town architect's office, borough engineer's office, chief constable's office, gas manager's office, public slaughter-houses, epidemic hospital, police surgeon's house, borough engineer's house, water manager's office, public baths, sanitary inspector's office, Works Department yard, medical officer's house, chief constable's house.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Medical Constant Current Electric Company (Limited).—The return of this company, made up to the 2nd ult., was filed on the 20th ult. The nominal capital is £100,000, in £1 shares. 48,007 shares have been allotted and the full amount has been called and paid upon each. Registered office, 38, Lombard Street.

Brush Electric Light and Power Company of Australasia (Limited).—The return of this company, made up to the 28th of August, 1882, was filed on the 24th ult. The nominal capital is £51,000, divided into 500 shares of £100 each, and 200 founders' shares of £5 each. 350 ordinary shares have been allotted and £60 per share called up. The founders' shares have all been issued, and are considered as fully paid. The calls paid (exclusive of nominal amount of founders' shares) amount to £21,000. At an extraordinary meeting of the company, held on the 29th of January, it was resolved to wind-up voluntarily, the company taking power to sell its patent rights to the Australasian Electric Light, Power, and Storage Company (Limited). This resolution was confirmed on the 21st ult., and Mr. F. S. Isaac, of 22, Great Winchester Street, and Mr. Cecil Lowry-Wade, of 18, Old Broad Street, were appointed liquidators. Registered offices, 4, Copthall Buildings, E.C.

Anglo-American Brush Electric Light Corporation (Limited).—The second return of this company, made up to the 6th ult., was filed on the 20th ult. The nominal capital is £800,000, in £10 shares; 40,700 shares have been allotted. Upon 13,701 shares £10 per share has been called up, and £4 upon the remaining 26,999. The total calls paid amount to £245,006. Registered office, Belvedere Road, Lambeth.

Electric Portable Battery and Gas Igniting Company (Limited), formerly the Patent Electric Gas Igniting Company (Limited).—The second return of this company, made up to the 14th ult., was filed on the 20th ult. The nominal capital is £100,000, in £50 shares. 16,000 shares have been taken up, and the full amount has been called thereon. The calls paid amount to £74,630, leaving £5,370 unpaid. Registered office, 7, Queen Victoria Street.

Laing Electric Light and Power Co. (Limited).—The second return of this company, made up to the 19th ult., was filed on the 26th ult. The nominal capital is £1,000,000, in £10 shares. The number of shares allotted is 12,007, and upon these £10 per share has been called. The calls paid amount to £120,000, leaving £70 unpaid. Office, 4 and 5, Three Crowns Square, London Bridge.

NEW PATENTS—1883.

833. "Galvanic batteries." F. WALKER. Dated February 15.

850. "Electrical self-registering money tills, parts of which improvements are applicable for other purposes." B. W. WEBB. Dated February 16.

867. "Apparatus for generating and utilising electricity." F. M. NEWTON. Dated February 16.

871. "Improvements in incandescent lamps and in apparatus employed in conjunction therewith." O. E. WOODHOUSE, F. L. RAWSON, and W. H. COFFIN. Dated February 16.

899. "An improved joint or union contact for electric fittings." W. DEFRIES. Dated February 19.

913. "Electrical fuses and their application to electrical firing." S. J. MACKIE and J. S. WARBURTON. Dated February 19.

924. "A new or improved electric meter." A. S. BUTLER. Dated February 20.

927. "Improvements in secondary batteries, and in renovating or revivifying their plates." O. J. LODGE and J. S. PATTINSON. Dated February 20.

931. "Printing telegraphs." H. J. ALLISON. (Communicated by S. D. Field.) Dated February 20.

940. "Electric cables or conductors." A. M. CLARK. (Communicated by L. A. Fortin-Herrmann.) Dated February 20.

941. "Improvements in the manufacture of uninflammable and incombustible products for writing and printing purposes, for paper-hangings, stage scenery, modelling, moulding, and other decorative purposes, for covering electric wires and cables for withstanding the action of acids, for decorating ceramic and other ware, and for other analogous purposes." A. M. CLARK. (Communicated by G. Meyer.) Dated February 20.

945. "Tanning leather by electricity." L. GAULARD. (*Complete.*)

951. "Improved electric arc lamps." H. TROTT and C. F. FENTON. Dated February 21.

965. "Transmitting audible signals by means of electricity." A. F. ST. GEORGE. Dated February 21.

973. "Dynamo-electric machines." J. HOPKINSON. Dated February 22.

985. "Method of and apparatus for forming letters or other characters on paper or other material from a distance." M. T. NEALE. Dated February 23.

1014. "Improvements in tramways, and in apparatus for propelling tram-cars by electric or steam-engines." M. H. SMITH. Dated February 24.

1015. "Improvements in galvanic batteries and in their construction." O. C. D. ROSS. Dated February 24.

1016. "Electric, secondary, or storage batteries." R. H. COURTENAY. Dated February 24.

1019. "Operation of electrical generators by gas-engines." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated February 24.

1020. "Improved method of applying variable resistance to electric currents without commutator." L. GAULARD and J. D. GIBBS. Dated February 24.

1022. "Construction of electrical railways." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated February 24.

1037. "An improved method of generating electricity." A. M. CLARK. (Communicated by H. A. Archereau.) Dated February 26.

1043. "Treatment of metallic ores by the combined action of electricity and water, and apparatus employed for the purpose." W. J. TANNER. Dated February 27.

1059. "Telephonic apparatus, applicable also to other purposes." L. J. CROSSLEY and W. EMMOTT. Dated February 27.

1077. "New plastic compound suitable to be rolled into sheets and used as a substitute for ebonite, also to make battery cells and other articles." W. SMITH. Dated February 27.

1079. "Mechanical telephone apparatus, chiefly designed for a central office or exchange system." H. J. ALLISON. (Communicated by G. F. Shaver.) Dated February 28.

1093. "Preparing insulated wires." H. E. NEWTON. (Communicated by A. A. Cowles.) Dated February 28.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

2823. "Generating and storing electric energy." CARL WESTPHAL. Dated June 15. 8d. Has for its object to diminish the loss of energy occasioned by the usual mode of converting heat into electric currents, which loss results greatly from the application of a motor and a dynamo-electric machine as intermediate carriers. The principle of the invention consists in producing from coals a constant current of electricity by means of water, gas and oxygen or atmospheric air, which gases are applied for artificially producing on plates or electrodes the same condition or state assumed by the latter during the electrical decomposition of water.

2962. "Incandescent electric light lamps." M. VOLK. Dated June 22. 2d. Relates to the construction and application to what are generally called incandescent lamp holders of a switch mechanism for controlling the lamp. (*Provisional only.*)

2974. "Producing electric light." O. G. PRITCHARD. Dated June 22. 2d. Has for its object to obtain an absolutely permanent or fixed arc light of almost any required illuminating power (from 25 to 50,000 candles). The invention consists in the combination with the electric arc of a gas flame forming a sort of path for the arc, and of finely divided carbon supplied to the arc in a constant stream to impart by its incandescence the desired intensity to the light. (*Provisional only.*)

2990. "Machinery for generating, controlling, and utilising electric currents." J. H. JOHNSON. (Communicated from abroad by La Campagnie Electrique of Paris.) Dated June 23. 6d. Relates to apparatus to be employed in the transmission of energy or motive-power by means of electricity, and it consists in improvements in the construction and arrangement of the electric-motors and generators and the apparatus for controlling and regulating the speed of these machines.

2992. "Apparatus for regulating the action of electric arc lamps, &c." W. R. LAKE. (Communicated from abroad by J. M. A. Gérard-Lescuyer, of Paris.) Dated June 23. 8d. Relates to improvements in apparatus for regulating the action of electric arc lamps, which improvements are partly applicable for other purposes. The said invention consists more particularly in a special construction of brake for keeping the upper carbon in position. The said invention further consists in various novel features in the construction and arrangement of various parts of the said apparatus.

3002. "Dynamo-electric machines." P. JENSEN. (Communicated from abroad by D. A. Schuyler and F. Goodyear Waterhouse, both of New York.) Dated June 24. 8d. The first part of this invention relates to a novel arrangement of the armature coils in a dynamo-electric machine and a new plan of connecting the coils to one another and to the commutating devices of the machine. The invention consists in dividing the coils or helices on the armature into sets of four, the coils in each set being disposed symmetrically with relation to one another, in such a way that each coil of a set is placed at an angle of 90 degrees from its two neighbouring coils in the same set and diametrically opposite to the remaining coil of the set. If the armature contained 8 bobbins or coils there would be two sets of coils of 4 bobbins each, and the bobbins or helices of one set would be placed between bobbins or helices of the other. If the armature be divided into 12 bobbins, its bobbins would be arranged in 3 sets, and any 3 contiguous bobbins would belong each to a separate set or group, but in every case the bobbins of each group would be spaced and disposed with relation to one another in the manner already described. Each set or group is provided with a separate commutator ring or cylinder, and one end of each helix or bobbin in a set is connected to a separate plate or segment of the commutator. With the arrangement of field of force poles herein indicated diametrically opposite bobbins would be connected to diametrically opposite segments. The remaining ends of the coil are bunched or in permanent electrical connection with one another.

3003. "Telephonic wires, insulating compounds, and transmitter and receiver diaphragms." A. WILKINSON. Dated June 24. 4d. According to the first part of the invention the inventor constructs or forms hollow (!!!) wire for increasing sound for long distance telephonic communication. According to the second part of the invention the inventor coats the hollow prepared wire with a compound composed of india-rubber, gutta-percha, tallow, naphtha, to which a small quantity of ground cork is added, this, with a suitable quantity of pitch or bituminous matter, may be readily brought into a plastic condition by the influence of heat, and "served on" as a protection to the said tube of wire. According to the third part of the invention, the diaphragms of telephone receivers and transmitters are made of common felt such as that used in a hat manufactory; they are worked under the influence of heat to any desired shape or form that may be requisite. The felt is prepared in a compound composed of, say, one pound of gutta-percha and india-rubber together with four pounds in weight of shoddy, mungo, or any suitable fibrous material mixed with one pound of wheat-flour, six ounces of tallow, four ounces of bi-sulphide of carbon, to which a small quantity of common pitch may be added. This mass may be readily stirred and mixed together and brought into a plastic condition, when it may be readily rolled out into sheets or moulded into shape after being subjected to hydraulic or powerful screw pressure.

3007. "Machinery for the regulation of speed in machinery driven by electricity, &c." FLEEMING JENKIN. Dated June 24. 6d. The object of the present invention is to provide means by which the speed of any machine, or part of a machine, driven by an electrical current may be maintained constant or adjusted independently of variations in the resistance to be overcome, or in the source from which the electrical energy is derived, or in the circuit, or in the number of machines to be driven by that circuit. The simplest mode of effecting this object is to provide power in excess of that required to drive the machine, if this power were continuously made use of; then, by means of a centrifugal governor, to disconnect the machine from the source of power for a greater or less percentage of the whole time during which the machine runs. The percentage of time during which the power is applied is regulated by the governor so as to produce the speed required.

3010. "Electric lamps with incandescent conductors, &c." W. E. DEBENHAM. Dated June 26. 4d. Relates to lamps used with an incandescent conductor, and its objects relate first to providing against effects of different rates of expansion in the platinum or other conducting wire and in the glass surrounding it, and secondly

to modifying the ill effects of the heating of the conducting wire and consequent unequal heating of the neck of the glass globe. Also to the material and method of forming the carbon conductor or filament, especially at or round the point or line of metallic contact, and to the making good electrical connection between the carbon and the metallic conductors. Also to the junction of the glass globe whereby it is connected electrically with the permanent and fixed conductors from the generator.

3025. "Dynamo-electric machines, &c." E. A. SPERRY. Dated June 27. 10d. Relates to improvements in dynamo-electric machines, electric lights, &c., the object being first to subject a greater proportion of the wire wound on the armature to an intense magnetic field; second, to construct the core of a transversely wound annular armature equi-distant from both its interior and exterior surfaces; to reduce the "magnetic inertia" of said core to a minimum to prevent induction of currents in the mass of metal forming said core, and to facilitate the dissipation of heat; third to automatically control the current to secure uniformity thereof, also to secure automatically differences in the intensity of the current generated by the machine; fourth, to secure in an electric lamp a more delicate adjustment of the regulating magnet than has been heretofore accomplished to control the carbons by mutual action of two helical systems, one of which is the moving element; to provide a sensitive frictional clutch whereby the carbon holder is delicately controlled by suitable mechanism; to automatically short-circuit lamps, when for any reason, the magnetism of its regulating system falls below a certain specified amount, and to offer a free passage for the current independent of the lamp at all times, except when said lamp is operated by a current of normal strength.

3033. "Production of carbons for incandescent electrical illumination." F. S. ISAAC. (Communicated from abroad by Sir Julius Vogel whilst on his voyage to Australia.) Dated June 27. 2d. Relates to the production of carbons capable of being employed in what are known as incandescent electrical lights, and it consists in preparing for such purpose the fibre of what is known as Rubus Australis Parsona Lygodium, or commonly as Supple Jack when occurring in New Zealand. The fibres having been freed from impurity, may be employed, when carbonised, in incandescent lamps, and the system or method of carbonisation to which it is preferred they should be subjected may be any of those now generally adopted, viz., by heating with carbon or otherwise as is well understood.

3036. "Dynamo-electric machines." W. E. AYRTON. Dated June 27. 6d. The first part of the invention consists in the use of a combination of steel and wrought iron in the field magnets of a dynamo-electric machine. The second part of the invention consists in a method of winding any ring armature with wire. The third part of the invention consists in a method of connecting up when any even number of pairs of field magnets are used near the armature. The fourth part of the invention consists in the strengthening of the arrangement of magnets. The fifth part of the invention consists in the use of a core for the armature of phosphor-bronze, or brass, or steel, or any other strong material, with a great many rivets of soft iron passing through it.

3042. "Incandescent electric lamps." F. L. WILLARD. Dated June 28. 6d. Consists in improvements in the construction of incandescent electric lamps, and has for its object the prevention of rupture of the filament by permitting it to expand and contract freely. This is accomplished in the manner shown by figs. 1 and 2. Fig. 1 shows the form of bulb or cylinder is preferred to use; A B are

FIG.1

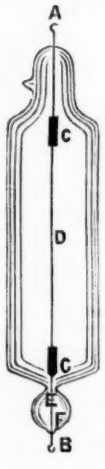


FIG.2

the leading in or terminal wires; C is a joint, and D the filament. E is a connecting wire dipping into the smaller bulb, F, filled with mercury. Fig. 2 shows another form which is identical with fig. 1, but the bulb, F, is filled with granules of metal, in place of mercury, and has two necks, the wire being steadied by these.

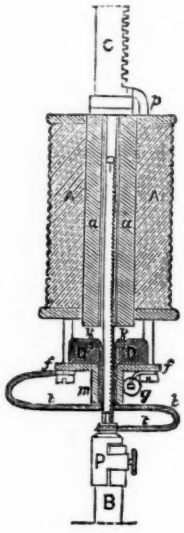
3047. "Telephone receivers." W. SPENCE. (Communicated from abroad by M. Kotyra, of Paris.) Dated June 28. 6d. Consists in the adaptation and application to telephone receivers of compound magnets of a particular form.

3048. "Insulating and protecting telegraph wires." G. MACAULAY-CRUIKSHANK. (A communication from abroad by W. E. Banta, of America.) Dated June 28. 6d. This invention is more particularly designed as a means for conveying the wires of telegraphs and telephones in subterranean or other closed conduits. The said invention consists first in a supporting and insulating case or enclosure for telegraph wires and other electrical conductors formed of a series of troughs hermetically connected, and hermetically closable by a coping, the said troughs being provided interiorly with posts and spools for the support and attachment of the wires.

3054. "Apparatus for regulating the production of electricity." J. C. MEWBURN. (Communicated from abroad by F. Rigaud, of Paris.) Dated June 28. 2d. By means of the invention the speed of the engine is kept constant, and the electrical condition of the machine which generates the current is never modified. (*Provisional only.*)

3061. "Magnetic compasses." F. BETBEDER. (Communicated from abroad by Eugène Bourse, of Rochefort-sur-Mer.) Dated June 28. 6d. Relates to an improvement in magnetic compasses, and is chiefly designed for mariners' compasses; and the improvement consists essentially in floating the compass card upon a liquid instead of hanging it upon a pivotal pin as usual.

3070. "Electric arc lamps." E. DE PASS. (Communicated from abroad by C. Roosevelt and B. Abdank, of Paris.) Dated June 28. Relates to apparatus to be applied to various systems of electric lamps for the purpose of instantaneously relighting the same if by



any accident they become extinguished, or if the resistance of the arc exceeds a predetermined limit. According to this invention a rack, C, carries the positive carbon, B, of any lamp. The carbon is fixed at the bottom of a toothed rod, T T, working within an orifice extending through the iron core, *a*, of the electro-magnet, A. The current enters through the rack (or in any other suitable manner) passes through the coils of the magnet, then through a flexible connection, *t t*, of fine copper wire, and enters the carbon. D D is a soft iron armature, provided at bottom with a sleeve which extends into the tubular socket, *m m*, of a support, *f f*. In a slot in this socket, *m m*, is a pawl (or a break) which operates when the armature, D, is raised; then the roller, *g*, upon whose arbor a spring (or a counter weight) presses, acts in such a manner that the pawl, *h*, engages the rod, T T, which is thus caused to follow the movement of the armature, D. The working of the apparatus is as follows: If the lamp be not alight, the armature, D D, occupies the position shown in the drawing, the rod, T T, is free, and the positive carbon, B, rests on the negative carbon. At the moment at which the current passes, the armature, D D, is raised, the pawl, *h*, engages the toothed rod, T, and the positive carbon is raised. The first separation required for lighting an arc lamp is thus effected. If the working of the lamp be regular the delicate movement of the rack (or other carbon carrier according to the system of regulation used with this invention) suffices for the regulation. But if an accident should occur—for instance, should the carbons break—the armature is released, the rod, T T, is disengaged, and the upper carbon descends until it bears against the lower carbon; at this moment the armature is again attracted and effects the required separation of the carbons. In this manner the lamp cannot become permanently extinguished, as the relighting, in case of extinction, takes place instantaneously. Set screws, *v v*, serve to regulate the distance of the armature from the core, so as to vary the effect of the force of attraction. (Described fully in ELECTRICAL REVIEW for September 9th, 1882.)

3073. "Electric railways and tramways." H. BINKO. Dated June 29. According to one part of the invention, the inventor proposes to increase the electromotive force of the dynamo or dynamos constituting the electro-motor on the locomotive by so arranging the wheels of the additional vehicle or vehicles hauled, as that some or each of them shall collect from one of the rails or other conductor an additional quantity of electric current, which is conveyed from the vehicle or vehicles hauled by means of conductors to the dynamo or dynamos on the electro locomotive, thereby greatly increasing the power of the same. (*Provisional only.*)

3079. "Electric lamps." J. H. JOHNSON. (Communicated from abroad by L. Bardon, of Paris.) Dated June 30. 2d. The improvements forming the subject of this invention are applicable to all descriptions of electric lamps in which the light is produced by the voltaic arc. The said improvements render the light extremely steady and constant, and consist in causing the upper carbon to descend very slowly when the arc is lengthened in lieu of descending suddenly as in the case of a great number of electric lamps heretofore employed. (*Provisional only.*)

3097. "Secondary batteries." A. WATT. Dated June 30. 2d. According to one part of the invention the inventor produces an alloy or mixture of lead and zinc or other metal electropositive to lead in granulated form by preference, by pouring the alloy in a molten condition into water, or by disintegrating it so as to form a fibrous or woolly mass by subjecting the metal to the action of a jet of high-pressure steam, air or other fluid. This product is then formed into cohering masses or slabs by pressure, which slabs may then be surrounded by a framework of lead cast on, or it may be placed in a perforated or permeable casing or box of insulating material, such as insulite, slate, earthenware, and the like. (*Provisional only.*)

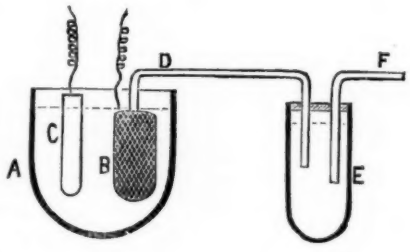
3099. "Preparation of carbon filaments." A. R. LEASK and F. P. SMITH. Dated June 30. 2d. Carbon filaments require to be specially treated after they are made to regulate the amount of their resistance to the current, and to make them of even resistance throughout their length. This is usually done by placing them in a vessel containing carburetted hydrogen gas and passing a current through them—technically known as "flashing." The improvements relate to the appliances or apparatus to be employed in the "flashing" process. (*Provisional only.*)

3101. "Electric lamp." R. H. COURTENAY. Dated June 30. 6d. Relates to a peculiar gripping arrangement for regulating the carbons in arc electric lamps, by which an improved electric lamp is obtained.

3107. "Secondary batteries." C. H. CATHCART. Dated July 1. 4d. Relates to the construction of the secondary battery described in a provisional specification filed by the inventor and C. B. G. Cole on the 2nd of May, 1882, No. 2068. The present improvements have for their object to prevent as far as possible the polarisation of the positive plates of such secondary batteries, which causes a constant waste of electrical energy; to allow of free circulation of the liquid in the battery; and to secure a firm deposit of metal on the positive plate when the cell is fully charged. This is accomplished by giving to the positive or zinc plates of such batteries a very large extent of surface within a small compass by using perforated zinc bent into various shapes. The perforation of the zinc allows of the free circulation of the liquid, and the metallic deposition takes place not only on the outer surfaces but also on the inner surfaces of the plates (brought about by the configurations of the same).

3108. "Secondary batteries or magazines of electricity, &c." H. J. HADDAN. (A communication from abroad by C. F. Brush, of America.) Dated July 1. 2s. 4d. Relates to secondary batteries or apparatus for the absorption of electric energy and subsequent exhibition of the same, and also to apparatus for use in connection with secondary batteries, whereby a number of said batteries can be grouped under and operated as an automatic system. This patent is too lengthy for abstraction.

3120. "Galvanic batteries." J. H. DAVIES. Dated July 1. 6d. The object of this invention is to produce electric currents directly from the combustion, or combination with oxygen of carbon, or carbon compounds. The method employed is illustrated by the figure,



which represents one of the simplest forms that can be given to the battery. A is a vessel containing nitrate of potassium, which is melted by heat. In this is immersed a plate of carbon, C, having a wire attached to it, also a kind of cage, B, made of fine iron wire gauze, or netting of several thicknesses, and into which is carried the tube, D. The tube, D, may be of the same material as the cage, B, or of glass, porcelain, or earthenware. The tube, D, and also the tube, F, pass through the stopper of another vessel, E, in which nitric acid is contained or generated, while to the outside end of F is connected a tube from any convenient reservoir of air. When air is forced through F it carries with it into D and B fumes of nitric acid, and this mixture finds its way through the meshes of the cage, B, into the melted nitrate of potassium. It will then be found that on connecting the wires from the carbon, which is the positive element, and the iron cage, which in conjunction with the mixed gases is the negative element, that a strong current of electricity is produced. It is not altogether necessary that nitric acid fumes should be employed, for a good result may be obtained by simply passing air alone into D.

CITY NOTES, REPORTS, MEETINGS, &c.

The Telegraph Construction and Maintenance Company (Limited).

THE nineteenth ordinary general meeting of this company was held at the offices of the company, 38, Old Broad Street, E.C., on Tuesday, Sir Daniel Gooch, Bart., M.P., the chairman, presiding.

The Manager (Mr. W. Shuter) read the notice convening the meeting, and also the minutes, which were approved, of the general meeting on the 28th February, 1882, the half-yearly meeting on the 18th July, 1882, and the extraordinary general meeting on the 6th February last.

The annual report and accounts of the directors were held as read. The accounts show a net profit of £92,260 13s. after charging the interest on the debentures. To this sum must be added £60,394 12s. 9d., brought forward from last year, making a total of £152,655 5s. 9d. From this amount is deducted the interim dividend of 5 per cent., paid July 18th, 1882, amounting to £22,410, leaving £130,245 5s. 9d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, free of income-tax, leaving £63,015 5s. 9d. to be carried forward to the next account.

The Chairman said: I think I may congratulate you upon the continued success of our company. The accounts show that during the past year the net profit amounted to £92,260 13s., and after pay- the interest on the debentures, and the interim dividend of 5 per cent. in the middle of last year, there is a balance available of £130,245 5s. 9d. The 15 per cent. which it is now proposed to distribute will, including the amount already paid, absorb all but £63,015 5s. 9d., which will be carried forward to the next account. The work that we have done in the past year is pretty clearly set forth in the report, but I shall just refer to it shortly. In the early part of the year a cable 550 miles in length was laid under a concession from the Austrian Government, between Corfu and Trieste, forming part of the Eastern Telegraph Company's system. The German Union Telegraph Company's cable was repaired in the North Sea, between Lowestoft and Greetseil. It was repaired during the winter and caused a great deal of trouble in consequence of the very bad weather. The cable, however, is now in an efficient working condition. The laying for the German Union Telegraph Company of a cable between Valentia, in Ireland, and Greetseil, in Germany, amounting to 776 miles, was completed in April. 254 miles of cable were manufactured for the Western and Brazilian Telegraph Company, and laid in April between Ceara and Maranham, on the Brazilian coast. The Brazilian Submarine Telegraph Company's cable, off Pernambuco, was at the same time repaired and the shore end relaid. Between the months of May and September extensive repairs were effected in the Anglo-American Telegraph Company's French Atlantic cable between Brest and St. Pierre, in depths up to 2,000 fathoms, after a submergence of thirteen years. I am sure it must be very gratifying to the shareholders to find that the cable after thirteen years' submergence has been raised and repaired and that it is now in very good condition—in perfect condition except where injuries had been done it—thus giving evidence that submarine cable property can be raised and repaired after many years' submergence in 2,000 fathoms of water. We may therefore now say that we do not know the length of the life of a cable. Great credit is due to the officers engaged in this work of repair, for it was very difficult work, but they have nevertheless been very successful. In the month of August the Eastern Telegraph Company's cable between Porthcurno and Lisbon was repaired in a depth of 2,700 fathoms, and a cable for the same company (234 miles in length) was manufactured and laid between Malta and Tripoli in October. The cable between Porthcurno and Lisbon, after being submerged five years, was found generally to be as clean and perfect as when laid. During the month of October the Brazilian Submarine Telegraph Company's cable between Lisbon and Maderia was duplicated, 663 miles of cable having been manufactured for this purpose; and the Lisbon shore end of the original cable was relaid. A cable, 965 miles in length, has been manufactured for the Eastern Extension Telegraph Company, which will be laid in the China Sea between Hong Kong and Shanghai. The steamer *Scotia* is now engaged in this work. Your works at Wharf Road and at East Greenwich are in excellent condition, as are also your steamships which are all engaged. The *Calabria* was engaged by the Government as a troopship during the Egyptian war, and she is now again on her way to Egypt for the Government. In hand at present we have the laying of about 900 miles of cables for the Eastern Telegraph Co., and 1,208 for the Great Northern Telegraph Co. These practically are the facts connected with the past year. With regard to the accounts, I do not think I can go through them, but I shall be glad to answer any questions any shareholder may put in regard to them or in reference to any other matter. I now have to move "That the report and accounts of the directors to the 31th December, 1882, submitted to this meeting be, and the same are, hereby received and adopted, and that a dividend of 36s. per share (in addition to the 12s. per share interest or interim dividend paid to June 30th 1882) be paid upon all shares of the company for the year ending December 31st, 1882, and that such dividend be paid free of income-tax."

Sir Thomas Fairbairn, Bart., seconded.

Mr. Newton said he was very glad to hear the chairman, who was a high authority in telegraph matters, say the life of a cable was much more than ten years, as it was not long ago since he heard an opposite opinion expressed by one who however was not so high an authority on the subject as the chairman. He should like to ask the chairman if the cables which were now being made, which were of a superior character to those made thirteen years ago, were likely to have a longer life. He thought some of the holders of submarine

telegraph property were doubtful as to whether their property was a secure investment, and the more that idea was dispelled the better it would be for that company and the companies for which they worked.

The Chairman replied that there could not be a doubt that the cables now manufactured benefited by the experience the last thirteen years had given them, and they felt certain the cables now made would last longer than those made thirteen years ago. They were now not only protected internally by brass ribbon, but externally by a composition which they believed would prevent the hemp from decaying and the salt water getting to the wires. There was every reason to believe that the present cables were much better and would last much longer than the original cables, although, as he had said, their length of life was uncertain.

The resolution was unanimously adopted.

Lord Alfred Paget and Mr. G. W. Campbell, the retiring directors, were re-elected.

Mr. John Gane (of the firm of Messrs. Gane and Jackson) and Mr. James Glegg (of the firm of Messrs. Quilter, Ball and Co.) were re-elected the auditors of the company, at remunerations of £150 each per annum.

The Chairman intimated that that concluded the business of the ordinary general meeting.

An extraordinary general meeting was then held, when

The Chairman moved:—"That the following special resolution, passed at the extraordinary general meeting of the company, held on February 6, namely, 'That the Bill now pending in Parliament, entitled, "A Bill for removing doubts as to and for extending the powers of the Telegraph Construction and Maintenance Company (Limited), and for other purposes," be and is hereby approved, subject to such conditions, alterations, and variations, if any, as Parliament may think fit to make therein,' be and the same is hereby confirmed."

Sir Thos. Fairbairn seconded, and this resolution was also unanimously adopted.

The Chairman: That concludes the business of the day.

Mr. Newton, in moving a vote of thanks to the Chairman and Directors, expressed his disappointment at not having heard something about the new electric light business.

The Chairman: I thought this was entered into at the last meeting.

Mr. Newton, continuing, said he had believed that the last meeting was only formal, and that this would have been the meeting. There had been such excitement in the electric world during the past twelve months that they should like to have an inkling as to what they were to be about. The directors had done their work so well in regard to telegraphs that they had not a competitor really in the whole world, and the shareholders wanted to know if they were to do something similar in the electric light world. He desired to know whether the shareholders would have the opportunity of inspecting the light at the Crystal Palace, or anywhere else, so that they should see something of the light that would be under the control of the company.

The Chairman said he did not make an explanation because he thought the matter was explained at the last meeting. By the Bill now before Parliament they desired powers to utilise electricity in every form in which electricity could be used, such as lighting which, with the appliances they had now got, they thought they could do with advantage to the shareholders; but as to exactly what they were going to do he thought they must wait before saying till they got the Bill through Parliament (hear, hear). He hoped they should get a fair share of the lighting of the country. They should do their best in the interests of the shareholders in the matter (hear, hear).

A Shareholder seconded the motion, which was unanimously adopted, and the meeting separated.

The Mediterranean Extension Telegraph Company (Limited).—The following is the report of the directors, submitted at the meeting held yesterday, a full report of the proceedings of which will be given in our next issue:—The balance-sheet shows a small falling off in the earnings of the company for the past half-year as compared with those of the corresponding half of the year 1881, which may be accounted for chiefly by the temporary interruption of the Corfu-Otranto Cable. The claim due from the Treasury for the five months ended the 2nd December, when the Government guarantee expired, is £3,000. This sum will suffice to pay the usual dividend on the preference stock, and also a dividend of 1½ per cent. on the ordinary stock. The Corfu Cable was repaired at a cost of £1,972, of which £1,241 3s. 4d. appears in this half-year's balance-sheet. Your directors beg to recommend payment of the usual dividend at the rate of 8 per cent. per annum less income-tax, and on the ordinary stock at the rate of 1½ per cent. per annum free of income-tax, which will leave £200 7s. 3d. to be carried to the reserve fund. In conclusion they have to state that the cables are in good working order.

The Submarine Telegraph Company between France and England.—An interim dividend of 18 per cent. per annum on the shares of this company was payable on the 1st inst., either at the Union Bank of London, 2, Princes Street, E.C., or at Mr. P. Gil's, banker, 6, Bouvelard des Capucines, Paris.

Western Union Telegraph Company.—The coupons falling due and the bonds drawn for payment on the 1st inst. are being paid by Messrs. Morton, Rose and Company, Bartholomew Lane, E.C.

The Edison Electric Light.—We observe that the Edison Company has received instructions to place incandescence lamps in the dining-room and library of the House of Commons. It is to be hoped that the softness and coolness of this light will have a soothing influence upon the Irish Members.

London Platino-Brazilian Telegraph Company.—The half-yearly coupons, which fell due on the 1st inst., of the River Plate and Brazil Telegraph 7 per cent. debentures, are being paid by Messrs. Glyn, Mills, Currie and Company, 67, Lombard Street, less income-tax.

Calls.—A call of £1 was due on the 1st inst. on the £6 paid shares of the Anglo-American Brush Electric Light Corporation; a call of £3 is due on the 31st inst. on the £5 paid shares of the Eastern Extension, Australasian, and China Telegraph Company, £10 shares issued at £1 premium; and a call of £91 was due on the 1st inst. on the £10 paid shares of the Great Northern Telegraph Company 5 per cent. debentures issued at 101.

The Stock Exchange Committee has ordered the following security to be officially quoted:—West Coast of America Company Telegraph (Limited), 8 per cent. debentures.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid	Closing Quotations. Feb. 28.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	6	4¼- 4¾	4¼.⅜.4⅛
		Do. Do.	10	7½- 8½	8½
30,000	5	Australasian Electric Light, Power & Storage Co.	3	¼- ⅜	
24,900	10	British Insulite Co., Limited, "A" Shares	5	2 - 3	
30,000	5	Brush Electric Light & Power Co. (Scotland)	2½	⅛- ⅜	
25,000	5	Great Western Electric Light & Power Co.	2½	⅛- ⅜	
24,980	5	Hammond Electric Light & Power Supply Co.	2½	3½- 3¾	3⅛.¾
40,000	5	Indian & Oriental Electrical Storage Works Co.	2	½- 1	
172,500	1	Maxim-Weston Electric Light and Power Co.	1	½- ¾	
40,000	5	Pilsen-Joel & General Electric Light Co.	2	½- 1	
..	..	South African Brush Electric Light & Power Co.	2½	¾- 1¼	
100,000	5	Swan United Electric Light Co., Limited	2½	1¾- 2½	
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	50½- 51½	
2,441,800*l.*	Stk.	Do. Preferred } Def'd. receiving no div. until }	100	81½- 82¾	82.¾
2,441,800*l.*	Stk.	Do. Deferred } 6 p. c. has been paid to Pref. }	100	18¾- 19¼	19
130,000	10	Brazilian Submarine, Limited	10	12⅜- 12⅝	
16,000	10	Cuba, Limited	10	9½- 10¼	
6,000	10	Do. 10 per cent. Preference	10	16½- 17⅞	
13,000	10	Direct Spanish, Limited	9	6 - 6¼	6¼
6,000	10	Do. 10 per cent. Preference	10	16 - 17	
65,000	20	Direct United States Cable, Limited, 1877	20	12½- 12⅝	12½.⅞.⅝
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	100 -103	
380,000	10	Eastern, Limited	10	10⅞-11¼	10⅞.11.¼.10⅞
70,000	10	Do. 6 per cent. Preference	10	13 - 13½	13½
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	100 -103	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	101 -104	102
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	103 -105	
199,750	10	Eastern Extension, Australasia & China, Limited	10	11⅛- 11⅜	11⅛.⅛.⅜.¼
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	100	107 -110	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	103 -106	105
140,000	100	Do. do. registered, repayable 1900	100	103 -106	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	103 -106	
254,300*l.*	100	Eastern and South African Limited 5 per cent. } Mort. Deb. Registered redeemable 1 Jan. 1900 }	100	103 -106	
345,700*l.*	100	Do. do. do. To Bearer	100	103 -106	
22,050	10	German Union Telegraph and Trust, Limited	10	10½- 11	
163,300	10	Globe Telegraph and Trust, Limited	10	6¼- 6¾	6⅛.⅛.⅜.⅛.
163,206	10	Do. 6 per cent. Preference	10	12⅜- 12⅝	12⅛.⅜
125,000	10	Great Northern	19	12 - 12½	
100,000*l.*	100	Do. 5 per cent. Debentures	100	101 -104	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	29½- 30½	29⅜.30.½.
100,000	100	Do. 6 per cent. Debentures, 1886	100	106 -108	
17,000	25	Indo-European, Limited	25	32 - 33	
38,148	10	London Platino-Brazilian, Limited	10	4¼- 4⅝	
12,000	10	Mediterranean Extension, Limited	10	1⅞- 2⅛	
8,200	10	Do. 8 per cent. Preference	10	6½- 7¼	7
9,000	8	Reuter's, Limited	8	10½- 11⅜	10½
280,000	Stk.	Submarine	100	260 -265	xd.
58,225	1	Do. Scrip	1	2¼- 2½	
4,200	Cert.	Submarine Cables Trust	100	105 -109	
37,350	12	Telegraph Construction and Maintenance	12	32½- 33¼	33 xd.
150,000	100	Do. 6 per cent. Bonds, 1884	100	101 -103	
186,750	5	Do. 2nd Bonus Trust Cert.	5	1¼- 1⅜	
30,000	10	West Coast of America, Limited	10	4⅜- 5⅛	
150,000	100	Do. 8 per cent. Debentures	100	106 -108	107
69,910	20	Western and Brazilian, Limited	20	7¾- 8	7⅞.8
200,000*l.*	100	Do. 6 per cent. Debentures "A" 1910	100	102 -105	
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80. red. Feb., 1910	100	99 -102	
1,500	$1,000	Western Union of U. S. 7 p.c.1 Mort.(Building) Bds.	$1,000	122 -126	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	102 -105	
88,321	10	West India and Panama, Limited	10	1¼- 1⅜	1⅜
34,563	10	Do. 6 per cent. 1st Preference	10	7 - 7⅛	
4,689	10	Do. 6 do. 2nd do.	10	5½- 6	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	⅛- ⅜	⅜ ⅛.⅜
225,000	1	Oriental Telephone Co., Nos. 80,001 to 305,000	¼	⅛- ⅜	
100,000	5	United Telephone Co.	5	11¼-12¼	12.11⅞.12. 11⅞.12

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company. The traffic receipts for the week ending February 23rd were £3,455.

The West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half-month ending February 15th are £3,267, as compared with £2,983 in the corresponding period of 1882. The November receipts, estimated at £2,700, realised £2,707.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending February 9th, 1883, were £2,542, for the week ending the 16th £2,523, and for the week ending the 23rd £2,276, each after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited.